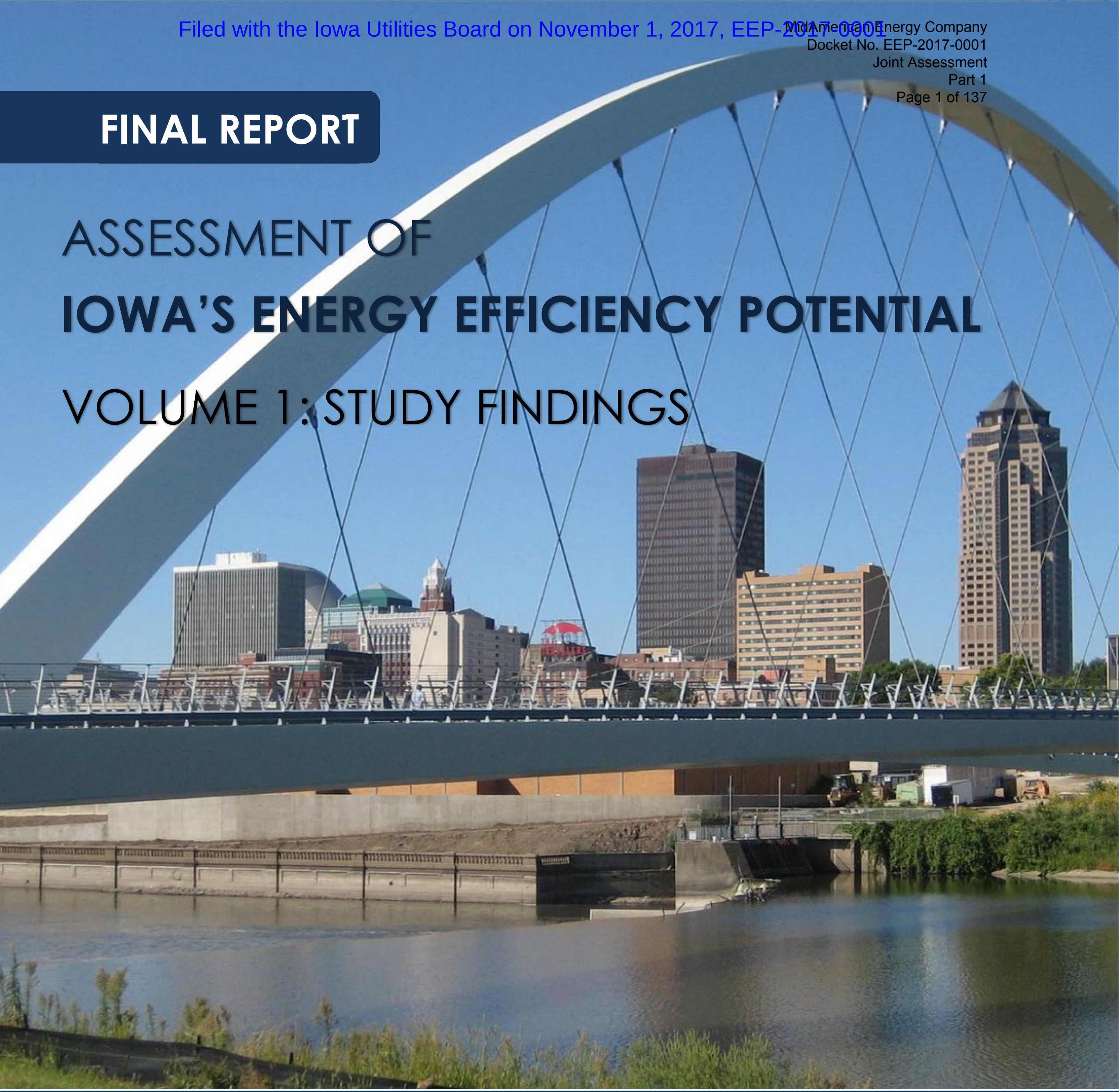


FINAL REPORT

ASSESSMENT OF
IOWA'S ENERGY EFFICIENCY POTENTIAL
VOLUME 1: STUDY FINDINGS

Submitted to: **IOWA UTILITIES ASSOCIATION**

Prepared by: **DUNSKY ENERGY CONSULTING**

with **MICHAELS ENERGY** and **OPINION DYNAMICS CORPORATION**

Contact: Alex Hill, Senior Consultant and Principal

Sept 25, 2017

dunsky ENERGY CONSULTING

ASSESSMENT OF ENERGY EFFICIENCY POTENTIAL

FINAL REPORT

SUBMITTED TO:

IOWA UTILITY ASSOCIATION

PREPARED BY:

DUNSKY ENERGY CONSULTING
with Michaels Energy and Opinion Dynamics Corporation

Contact:
Alex Hill
Senior Consultant and Principal
Dunsky Energy Consulting
50 Ste-Catherine St. West, suite 420
Montreal, Canada H2X 3V4

T: 514 504 9030 ext. 30
E: alex.hill@dunsky.com

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AOP – Assessment of Potential

BAU – Business as Usual

CF – Coincidence Factor

C&I – Commercial and Industrial

DR – Demand Response

DSM – Demand Side Management

EE – Energy Efficiency

EMS – Energy Management System

ER – Early Replacement

EUL – Estimated Useful Life

HERS – Home Energy Rating Score

iDR – Implicit Discount Rate

IOU – Investor Owned Utility

IUA – Iowa Utility Association

LC&I – Large Commercial and Industrial

LIHEAP - Low Income Home Energy Assistance Program

MEMD - Michigan Energy Measures Database

MF – Multi-Family

NC – New Construction

NEB – Non-Energy Benefits

NPV – Net Present Value

NTGR – Net-to-Gross Ratio

OBF - On-Bill Financing

O&M – Operations and Maintenance

ROB – Replace on Burnout

SB – Small Business

SCT – Societal Cost Test

SF – Single Family

TRM – Technical Reference Manual

EXECUTIVE SUMMARY

Dunsky Energy Consulting, in collaboration with its subcontractors Michaels Energy and Opinion Dynamics Corporation, conducted an Assessment of Potential (AOP) study for the Iowa Utilities Association (IUA). The Iowa AOP Study quantifies the gas and electric energy efficiency potential from IUA-member utility demand side energy efficiency programs over the 2018-2027 timeframe.

The Iowa AOP Study entailed four key elements:

- **Market Baseline Study:** Extensive primary research that captured the penetration and saturation of key energy-using equipment in a statistically representative sample of homes and businesses across the state.
- **Net-to-Gross Study:** Primary and secondary research into NTGR for current utility programs, in parallel to the Iowa AOP Study. The results of this study were applied in the AOP Model to assess the net achievable savings potential.
- **Utility Data Review:** A review and treatment of utility data and results from past programs and the Iowa Technical Reference Manual (TRM) to characterize market segments, efficiency measures and programs as well as perform base sale projections.
- **Iowa AOP Model Development and Delivery of Scenario Analysis Tool:** The application of Dunsky's Potential Model to construct a tailored Iowa AOP Model with a user-friendly interface. This tool is being delivered to the utilities and stakeholders as part of this study, and will be a valuable tool for performing scenario analysis for utility DSM program planning.

This report provides a high-level explanation of our study methods and modelling approach, as well as an analysis of the statewide potential for utility programs over the study period.

STATEWIDE ASSESSEMENT OF POTENTIAL

The Iowa AOP Study captured statewide results by combining efficiency potentials across the three utility service territories. Customer data from each utility was used to establish primary data collection sample frames, and assess market segment consumption breakdowns by size and fuel.

For each utility, a unique set of markets, economic factors, baseline projections, and DSM program characterization was developed. Measure savings and model calculation methods were then applied uniformly across each utilities' markets and the savings were rolled up into statewide totals. The Iowa AOP Report Volume 1 primarily presents the aggregate statewide findings, while utility specific results are provided in more detail in Volume 2.

This study was conducted for the Iowa Utilities Association on behalf of the three investor-owned gas and electric utilities:[1]

- MidAmerican Energy Company
- Alliant Energy - through subsidiary Interstate Power and Light Company
- Black Hills Energy

In each case, this study focuses exclusively on these utilities' Iowa service territories and customers.

POTENTIAL LEVELS ASSESSED

The Iowa AOP Study assessed three levels of potential: technical potential, economic potential, and achievable potential. In each case, these levels were defined with respect to the requirements and definitions specified in Chapter 35, as follows:

- **Phase-in Technical Potential:** The technical potential accounts for all theoretically possible energy savings stemming from commercially available measures. In markets where multiple measures may compete, the measure procuring the most energy savings per unit is selected. The technical potential is defined as the electricity and gas savings from these measures multiplied by the theoretical maximum number of units per year. It is phased in year-by-year based on the natural turnover of existing equipment, and a reasonable timeline for implementation of discretionary measures.
- **Economic Potential:** The economic potential includes all measures which pass the Iowa societal cost test (SCT) with a cost-benefit ratio of 1 or higher. Economic screening is performed at the measure level, and only accounts for measure costs and benefits, not including general DSM program costs. In cases where multiple measures may compete, the cost-effective measure offering the most savings per unit is included in the Economic Potential assessment.
- **Achievable Potential Scenarios:** The achievable potential is defined as the potential savings stemming from the best-in-class efficiency and demand response programs. Market shares of measures competing with each other within a given market are pro-rated using the respective measures adoption rates. The Iowa AOP Study assessed the achievable potential under three scenarios, as described in Table 1 below.

[1] Source: http://www.iowautility.org/ (accessed on July 20, 2017)

Table 1: Achievable Potential Scenario's Applied in the Iowa AOP Study

Scenario Name	Scenario Conditions
Business as Usual (BAU)	DSM programs are characterized using currently reported utility incentive and administrative costs and cost effectiveness screening is applied at the measure level for program eligibility.
Business as Usual *Plus* (BAU+)	DSM programs are characterized by a 25% increase in administrative costs to account for improved marketing and delivery to reduce customer barriers. Incentives are set at current levels, except in a few cases where the best in class programs suggest higher incentives are appropriate. Measures are screened for cost-effectiveness such that the resulting programs and portfolios maintain SCT values equal to or greater than one, except where otherwise specified (e.g. Low-Income programs).
Maximum Achievable	Applies the same conditions as in the BAU+ scenario, but with incentives set at 100% for all programs.
Financing Programs	Financing programs can be applied as an adder to any of the AOP Model scenarios, by engaging the Financing toggle on the AOP Model dashboard. Our analysis focused on the impact of including financing and incentive programs under the BAU+ case, but the scenario analysis AOP Model allows the user to assess the impact of financing under any of the incentive portfolio scenarios.

MARKET BASELINE STUDY – PRIMARY DATA COLLECTION

An in-depth Market-Baseline Study of the Iowa Residential and Non-Residential markets was conducted as a foundational element of the Iowa AOP study. By collecting primary data on the penetration and saturation of energy using equipment and quantifying the opportunities to apply energy efficiency measures in the various market sectors and segments, the Market Baseline Study was key to ensuring that the AOP was based on real Iowa conditions and data, rather than assumptions drawn from other jurisdictions. The following sections outline the approach taken to conduct the study, and further details are provided in Appendix C: Market Baseline Study Detailed Methodology.

PRIMARY DATA COLLECTION: RESIDENTIAL SECTOR

The primary data collection activities for the residential sector included a mail survey that yielded 1,540 customer responses and in-home visits at 100 homes. The mail survey and home visit sample sizes were designed to achieve a statistical representative sample of residential properties in Iowa. While the mail-survey offered a much larger number of responses, the home visits were performed by experts who were trained to recognize and assess equipment specifications. The home visits were therefore used to verify any ambiguities in the mail survey data and provide a deeper technical assessment of each home.

Figure 1: Residential Sector Primary Data Collection Steps

PRIMARY DATA COLLECTION:
COMMERCIAL AND INDUSTRIAL SECTORS (NON-RESIDENTIAL ACCOUNTS)

The primary data collection activities for the non-residential sectors included a telephone survey with 972 customers in the commercial and industrial sectors and on-site audits at a nested sample of 150 of these businesses.

Figure 2: Non-Residential Customer Primary Data Collection Steps

CONSUMPTION AND DEMAND BASELINE PROJECTION

The consumption and demand baseline projection is used to benchmark the effectiveness of an energy efficiency and demand response program portfolio over time. The baseline is also used to generate metrics and perform model calibration. Starting with data provided by the utilities, Dunsky modified it to develop the consumption and demand baseline for the AOP potential model. The forecasts were adapted to remove built-in assumptions regarding the impacts of utility programs.

IOWA ASSESSMENT OF POTENTIAL (AOP) MODEL

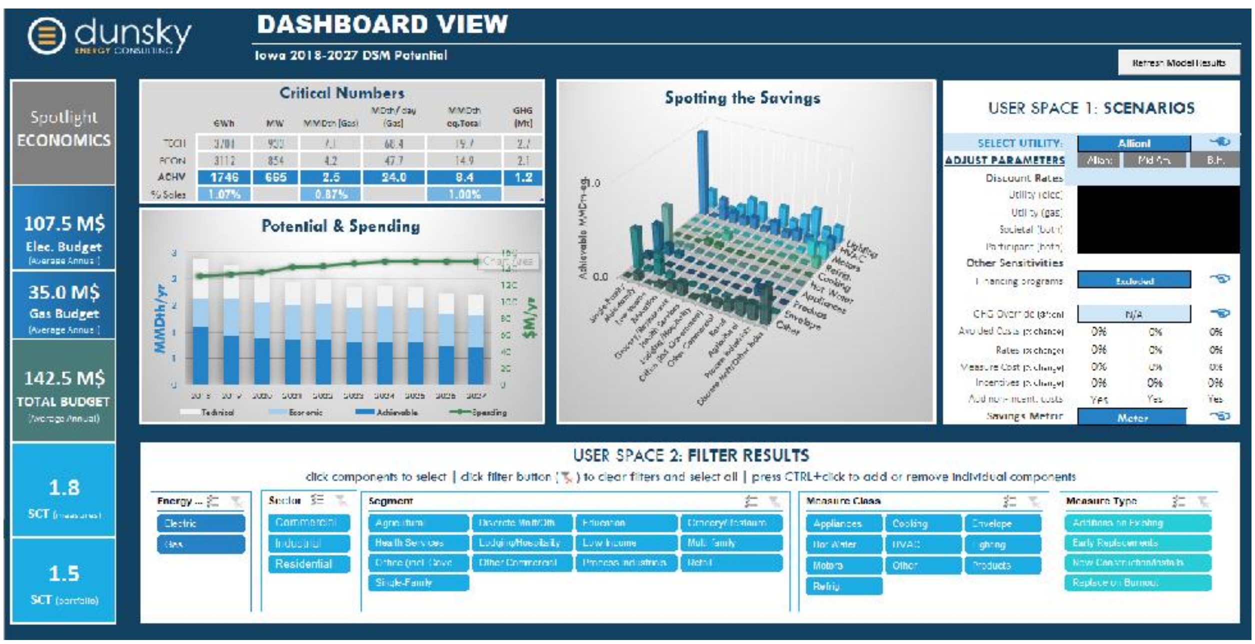
The Dunsky Team tailored our user-friendly, transparent and adjustable potential model, creating the Iowa AOP Model to assess the electricity and natural gas energy saving potentials for each of the three Iowa utilities.

Three models were created, one covering each utilities' customer base, and the characteristics were established with respect to measure inputs, equipment saturation, and measure adoption assumptions, as well as all economic and related parameters. The model captures electricity and gas savings, assessing the consumption and demand reduction potentials over the 2018-2027 period (10-year potentials). The model outputs provide disaggregation of the results at various levels, including separation of the gas and electricity potentials as well as disaggregation by sector, program type, end-use and measure.

IOWA AOP SCENARIO ANALYSIS MODEL

Accompanying this Final Report, we have provided the utilities and other identified stakeholders with access and a license to the Iowa AOP Scenario Analysis Model. The model includes the study's assumptions and full Technical, Economic and Achievable (BAU+) potential scenario results, and has been calibrated for each utility. Figure 3 presents a snapshot of the dashboard, which is the main entry point to use the model's features and run sensitivity analyses.

Figure 3: Iowa AOP Model – Dashboard View



The user also has access to measure and program input and output tables. Core input assumptions in the model are clearly defined and can be easily changed to conduct sensitivity analysis, and adjust to changing market conditions (e.g. energy prices, economic growth) as well as recent program and evaluation results.

APPLICATION OF MEASURE SCREENING AND ADOPTION IN THE AOP MODEL

The AOP model applies various screening methods to determine the technical, economic and achievable potentials. These include screens based on each measure's specific characterization (cost-effectiveness, market applicability), as well as interactive and competition effects among measures.

Table 2: Hierarchy of measure screening and adoption calculations at each level of potential assessment

CALCULATION STEPS	TECHNICAL POTENTIAL	ECONOMIC POTENTIAL	ACHIEVABLE POTENTIAL
1. ECONOMIC SCREENING	No Screen	Cost-Effectiveness (SCT)	Cost-Effectiveness (SCT and PCT)
2. MARKET BARRIERS	No Barriers (100% Adoption)	No Barriers (100% Adoption)	Market Barriers (Adoption Curves)
3. COMPETING MEASURES	Winner takes all	Winner takes all	Competition Groups
4. CUMULATIVE MEASURES	Chaining Adjustment	Chaining Adjustment	Chaining Adjustment
5. NET SAVINGS	Not Considered	Not Considered	Program NTGR

DELIVERY OF STUDY TOOLS

This Final Report captures and presents the Iowa AOP Model results under the defined scenarios.

- **Iowa AOP Model for Scenario Analysis:** A scenario analysis version of the Iowa AOP Model has also been made available to the utilities and the efficiency program stakeholders to test scenarios and update results to reflect changing market and economic conditions over the study period.
- **Detailed Penetration and Saturation Results:** Detailed Penetration and Saturation tables have been provided to the utilities capturing the detailed results of the Market Baseline Study.
- **Net-to-Gross Study:** Finally, in parallel to the AOP Study, we conducted research into the NTGR applicable to current Iowa Utility programs. This study was delivered to the utilities in June 2017.

IOWA AOP MODEL INPUTS

The Iowa AOP Model was populated with Iowa-specific inputs to create a representative tool that captures the range and extent of gas and electric saving opportunities in the utility service territories.

Key inputs include:

- **Utility Economic data**: including Dunsky rate projections, avoided costs of generation and supply, discount rates, inflation rates, number, type and stratified average consumption of customers, DSM program activities and impacts.
- **Characterized Energy Saving Measures:** including measure costs (full and incremental), energy savings per unit, assumed market barrier level, market growth, replacement schedule, estimated life, applicable segments and populations, among others.
- **Best-in-Class Program Characteristics:** including details on residential and C&I sector DSM programs covering retrofit and new construction approaches, demand response programs, and a residential behavioral program. Best-in-class program characteristics were modeled on current Iowa utility programs, adapting the incentive levels and marketing costs to match exemplary programs from other jurisdictions.
- **Special Programs:** including details on Low-Income, Tree Planting and Code-Compliance programs, as required under the Chapter 35 rules.
- **Financing Program Characteristics:** Details on the application of five utility delivered efficiency financing programs covering whole home retrofits, residential general measures, municipal, university, schools and hospitals (MUSH) financing, small businesses and large business.

The methods applied to characterize the full range of model inputs developed for the Iowa AOP Study are summarized within the body of the AOP Study report.

ENERGY SAVING MEASURE CHARACTERIZATION

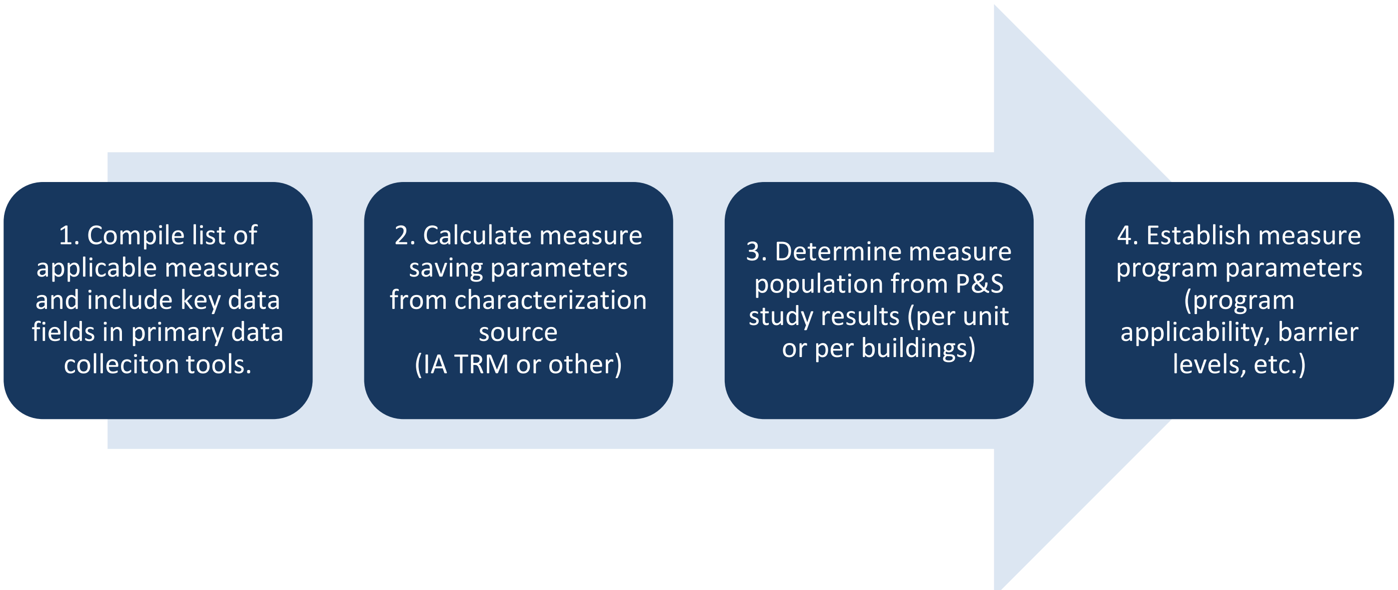
The Iowa AOP Model includes 1,958 measure-market combinations, representing the full range of commercially available technologies (current and emerging). The included measures were characterized primarily using the Iowa TRM in conjunction with the Market Baseline Study results to determine the population of energy saving opportunities for each measure, and the current baseline technology mix.

The model uses four types of measures:

- replacement on burnout (ROB),
- early retirement (ER),
- addition (ADD), and
- new construction/installation (NEW).

Each of these measure types requires a different approach for determining the maximum yearly units available for potential calculations. Using a list of measures approved by the utilities and stakeholders, we applied the measure characterization process steps outlined in Figure 4 below.

Figure 4: Measure Characterization Steps



PROGRAM CHARACTERIZATION METHODOLOGY

In the Iowa AOP Model, the bundled DSM programs are characterized for each individual utility to account for differences among their DSM portfolios, following the process presented in Figure 5 below. Each program bundle was characterized following a series of steps to ensure methodological consistency across programs, based on current Iowa utility program features and best in class examples from other jurisdictions.

Figure 5: Program Characterization Steps

Each program has five inputs that were characterized based on data that was received from the utilities and adjusted to reflect findings from a review of a jurisdictional scan of 42 best in class programs from five utilities. The Program characterization fields defined for each bundle are listed below:

- Fixed Administration Costs were defined as program costs that did not change with the potential model measure uptake.
- Variable Administration Costs were defined as program costs that did change with the potential model measure uptake.
- Incentive levels are the portion of measure incremental costs that are paid to program participants by the utility.
- Barrier Reductions refer to the ability of programs to reduced market barriers through effective marketing and program delivery.
- The Cost-Effectiveness Threshold indicates the minimum SCT value for which a measure can be included in the program.

NET-TO-GROSS RATIOS (NTGR) AND ACHIEVABLE NET-SAVINGS POTENTIAL

NTGR were applied on a measure-program combination basis to determine the Achievable Potential within the Iowa AOP Model. The NTGR were determined as part of a parallel study conducted alongside the AOP Study. For Technical and Economic Potentials NTGR were not applied to the savings. The NTGR were for each measure were set to the highest assessed NTGR from our study, assuming that all programs can be adjusted to meet the highest observed NTGR for a given measure. The same NTGR were used under all Achievable Potential scenarios, but the model can be adjusted to provide gross achievable savings potential by utility and program.

DEFINING BEST IN CLASS PROGRAMS

Dunsky performed a jurisdictional scan of best-in-class utility programs across the U.S. to help ensure that the achievable potential reflects what would be possible by applying the best program models available. In all, we scanned 42 programs from five utilities, reviewing key program design factors such as the marketing budgets and approaches, incentive levels, resulting impact and net-to-gross results (where available). The results supported adjustments to the program characterization settings within the Iowa AOP Model applied under the BAU+ and MAX program scenarios.

DEMAND RESPONSE PROGRAMS

Two demand response programs are included in the model, one for residential customers and one for non-residential customers. In each case we developed these programs based on the currently offered programs from Alliant and MidAmerican. Moreover, the impact of existing enrollment was included in the model results as it was removed from the base sales forecast along with the other efficiency programs.

For these programs, while the kW of enrolled DR capacity may be well defined, the annual kWh of savings from the programs is highly variable.

SPECIAL PROGRAMS (AS PER CHAPTER 35 RULES)

Chapter 35 requires that three "special programs" be included with the Iowa AOP Study. These programs are defined as:

- Peak demand and energy savings from programs targeted at qualified low-income customers, including cooperative programs with community action agencies
- Implementation of tree-planting programs; and
- Peak demand and energy savings from cost-effective assistance to homebuilders and homebuyers in meeting the requirements of the Iowa model energy code.[2]

In response to this requirement, we included the following three programs and the corresponding measures to capture the potential savings from these special program definitions.

EFFICIENCY FINANCING PROGRAMS

In order to incorporate EE financing programs into the Dunsky Potential Model, we first determined how financing programs may contribute to various components of the Potential Assessment, and which financing program features may have quantifiable impacts on measure adoption.

The Iowa AOP Model includes five archetype financing program bundles based on commonly applied utility program financing offers.

- Residential Whole Home Program
- Residential General Measures Program
- Municipal, University, Scholl and Healthcare (MUSH)
- Small Business (SB)
- Large Commercial and Industrial (LCI)

A financing program's **overall impact can be assessed in the model by comparing projected adoption with and without the financing program in place**: *Financing Program Impact = Δ Adoption*

By establishing the set of residential and non-residential programs that best represents the range of financing options offered by Iowa's utilities, a scenario analysis can be performed by toggling on and off various programs, and comparing the resulting achievable potential to the base case.

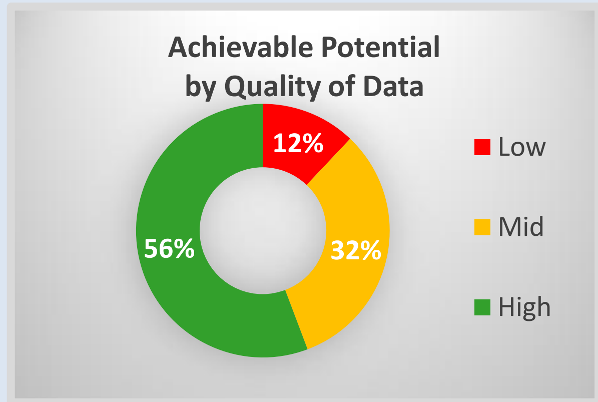
[2] Article 35.8(1), item d. in Chapter 35 legislation

IOWA AOP RESULTS

Iowa AOP Model Results

The Iowa AOP Study was based on extensive primary research to assess the market baseline for energy using equipment in Iowa homes and businesses across the three utility service territories. This data was then used as input to the Iowa AOP Model. In assessing the savings potential, the model tracks the portion of savings stemming from measure of varying input data quality.

Figure 6: Data Quality Behind Iowa AOP Model Savings Results



The high data quality savings arise from measures for which market baseline data was available for all segments, covering all or most measure characterization inputs. Medium quality inputs refer to measures where only a portion of segments had sufficient market baseline data. Low data quality data inputs refer to measures where only broad market data was available at the sector level, and default values were used for the majority of measure characterization inputs.

Figure 6 above shows the impact that the baseline data had on the quality of overall savings assessment from the three utility model results, showing that 88% of the savings stem from measures for which we applied Iowa specific and segment market data.

ELECTRIC POTENTIAL RESULTS

A detailed breakdown of the statewide electric achievable potential (under the BAU+ base case) is presented in the following section. Overall the results show that the residential sector represents the greatest electric achievable potential opportunity.

Figure 7: 10-Year Statewide Electric Potentials as Portion of Total Sales by Sector

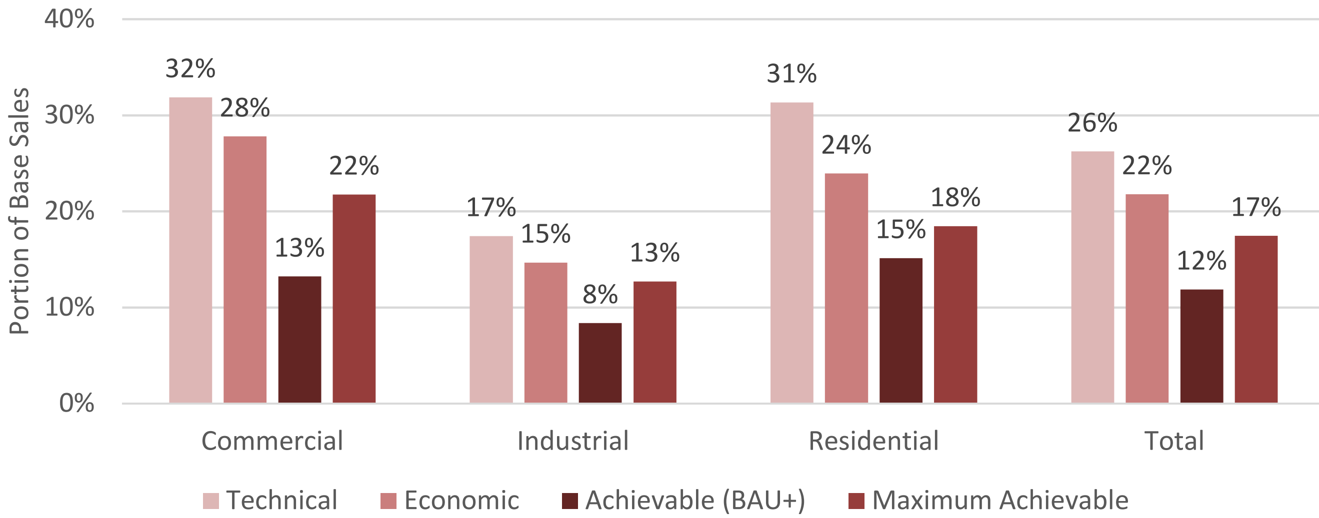
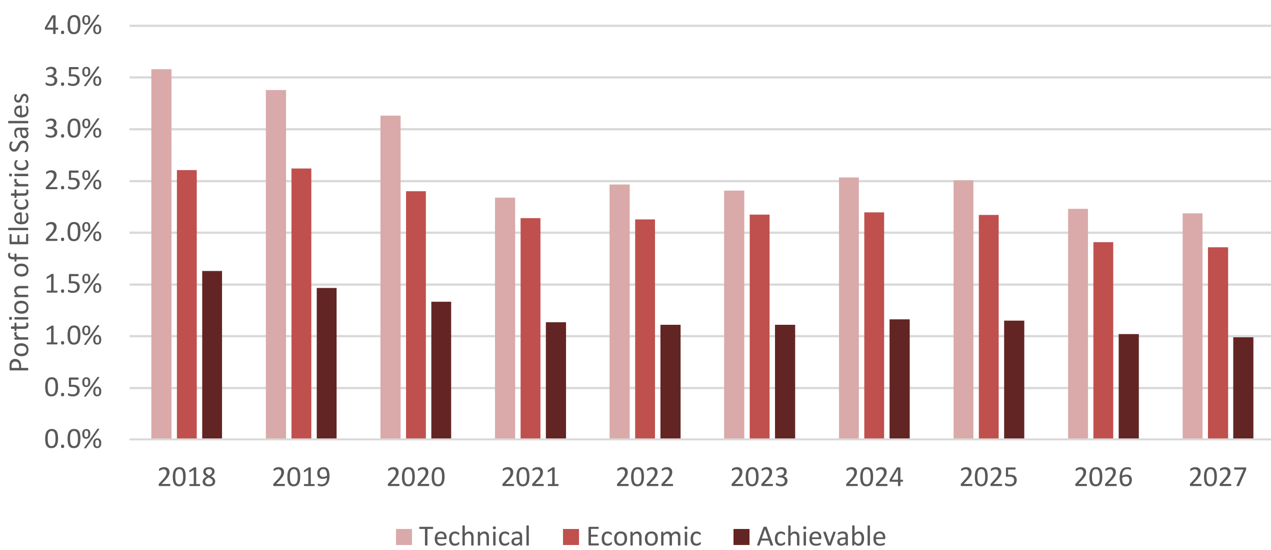


Figure 8: Statewide Annual Electric Potential as Portion of Electricity Sales



The statewide electric potentials are presented in Figures 7 and 8 above. From these results, the following observations can be made:

- **There is significant opportunity across the residential and non-residential markets:** The residential sector represents the greatest achievable potential terms of the portion of base sales, however the commercial sector offers the largest opportunity in terms of absolute GWh of savings. While cumulative residential savings may be large, achieving savings in this market requires successfully accessing a myriad of small savings opportunities (e.g. lighting and small HVAC equipment in homes and apartments).

- **Industrial sector potential is limited:** The industrial sector offers the lowest electric achievable potential in terms of the portion of base sales. However, its overall GWh of potential savings is larger than that for residential. Given this sector's high electric consumption per customer and the predominance of specialized process equipment, electric savings may be more easily accessed through larger initiatives customized to specific customer needs.
- **Customer economics and market barriers likely limit the non-residential market achievable potentials:** A very high portion of savings opportunities in the commercial and industrial sectors are cost-effective, where economic potentials represent 87% and 84% of the technical potential respectively. But the achievable potentials suffer, likely due to unfavorable economics at the participant level (i.e. lower PCT scores for measures in the non-residential sector due to lower energy prices).
- **Favorable customer economic support achievable potential in the residential sector:** In the residential sector, only 70% of identified technical savings opportunities are deemed cost-effective at the societal level, but the sector achievable potential remains high, likely due to favorable economics (i.e. reasonably short simple paybacks) at the customer/participant level.
- **Maximum achievable potentials approach economic potentials in general:** Maximum achievable potentials were assessed by setting incentive to 100% of measure incremental cost. Overall, this has the largest impact in the commercial sector, increasing customer economics and measure uptake significantly.
- **Industrial sector offers the highest potential demand savings:** While the residential and commercial sector electric demand achievable potentials are largely in line with their energy potentials, the industrial sector offers significantly higher demand savings, both in absolute terms (MW) and as a portion of base sales demand. This is attributed to high projected industrial customer participation in the Interruptible Demand Response programs.

Figure 9: 10-Year Achievable Electric Savings by Market Segment: All Sectors (GWh)

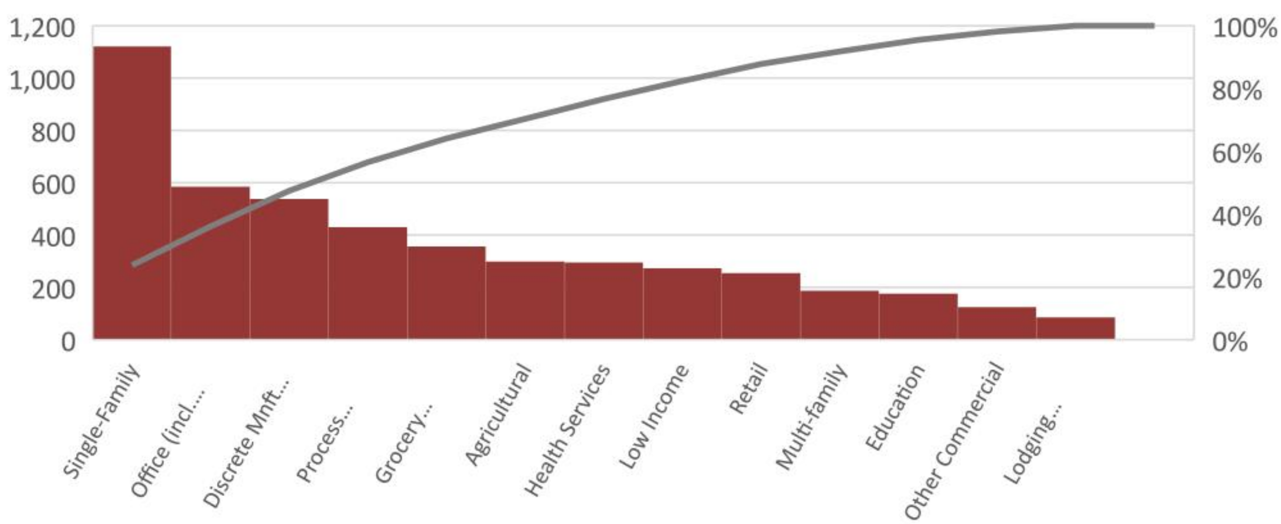
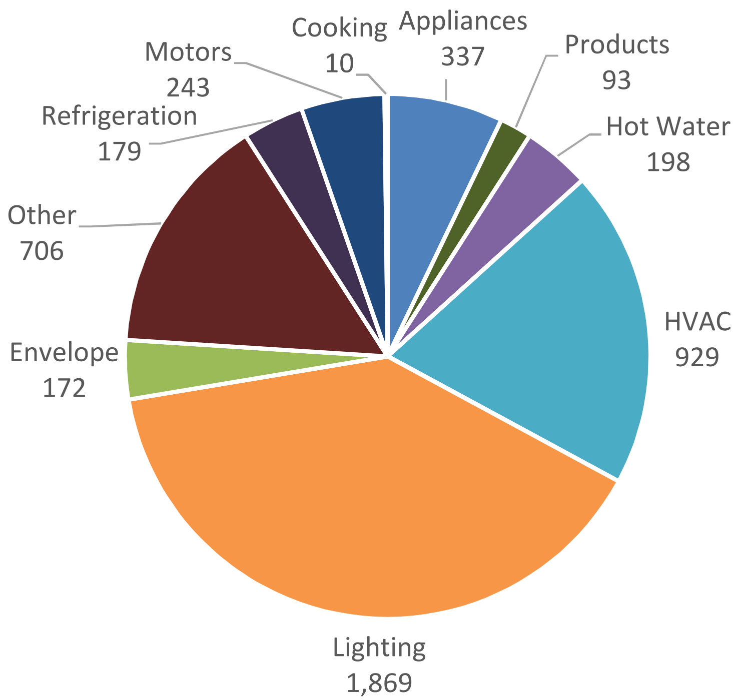


Figure 10: 10-Year Total Electric Achievable Savings by End-Use (Values in GWh)



GAS POTENTIAL

The gas potential results are presented below. Overall, they indicate that the residential sector holds the greatest opportunity for savings, related primarily to HVAC, water heating and envelope measures.

Figure 11: 10-Year Statewide Gas Potentials as Portion of Total Sales by Sector

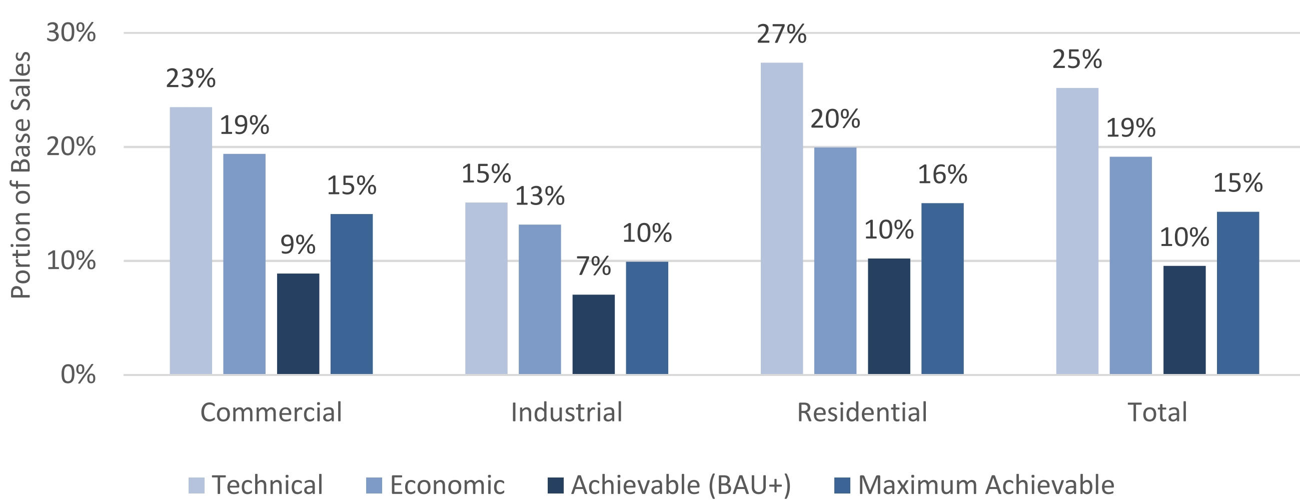
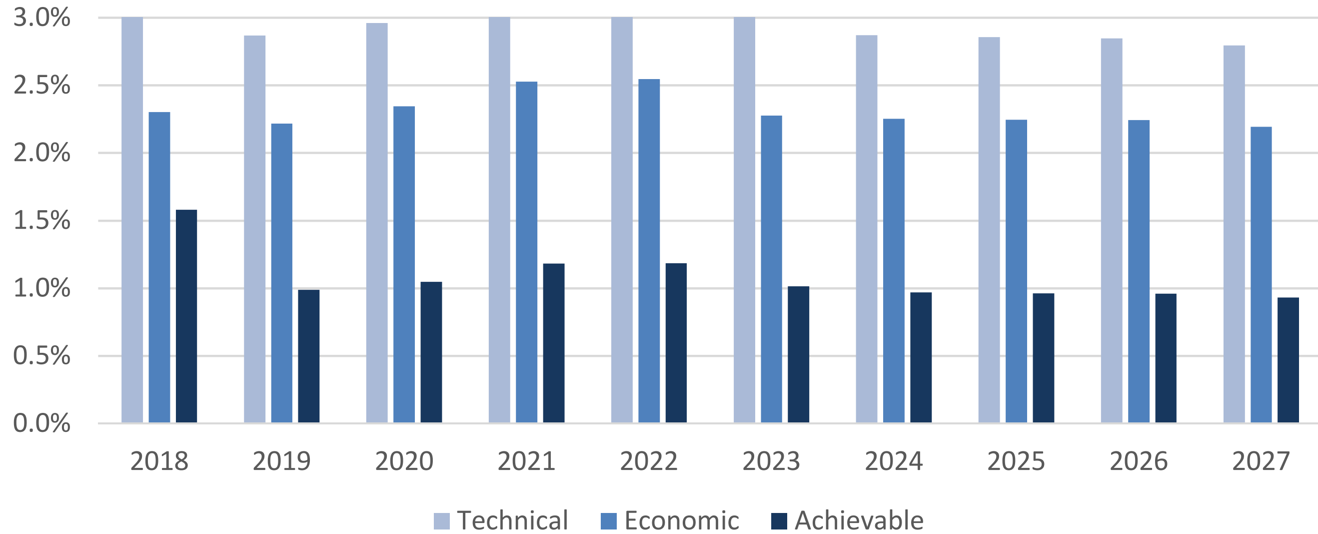


Figure 12: Statewide Annual Potential as Portion of Gas Sales



The statewide gas potentials are presented in Figures 11 and 12 above. From these results, the following observations can be made:

- **The residential sector represents by far the greatest gas savings potential:** The residential sector demonstrates the greatest achievable potential, compared to the commercial and industrial sectors, both in the portion of base sales and in absolute dekatherms of savings. While these savings may cumulatively be large, given the nature of the residential market, achieving these savings would require successfully accessing a myriad of small savings opportunities, mostly related to home furnaces, water heating and envelope improvements.
- **Industrial sector potential is limited:** The industrial sector offers the lowest gas achievable potential, both as a portion of base sales and in absolute terms.
- **Customer economics and barriers likely limit gas achievable potentials in general:** In all sectors, the economic potential of gas savings represents a high portion of the overall technical potential, averaging over 78% of the overall technical potential. However, the achievable potentials represent a much smaller portion, averaging just 50% of the economic potentials, which suggests that gas savings are limited primarily by customer economics and barriers.
- **Maximum achievable potentials approach economic potentials in general:** Maximum achievable potentials were assessed by setting incentive to 100% of measure incremental cost. Overall, this has the commercial and residential sectors, increasing customer economics such that the maximum achievable almost reaches the economic potential.
- **Residential sector offers the highest potential demand savings:** The residential sector offers the greatest gas demand savings potential both in absolute terms (MDth/day) and as a portion of base sales demand. This is attributed to the overall high portion of gas saving opportunities in the residential sector, and the likelihood that residential gas using equipment often has a high winter peak coincidence factor.

Figure 13: 10-Year Gas Savings by Market Segment: All Sectors (values in MDth)

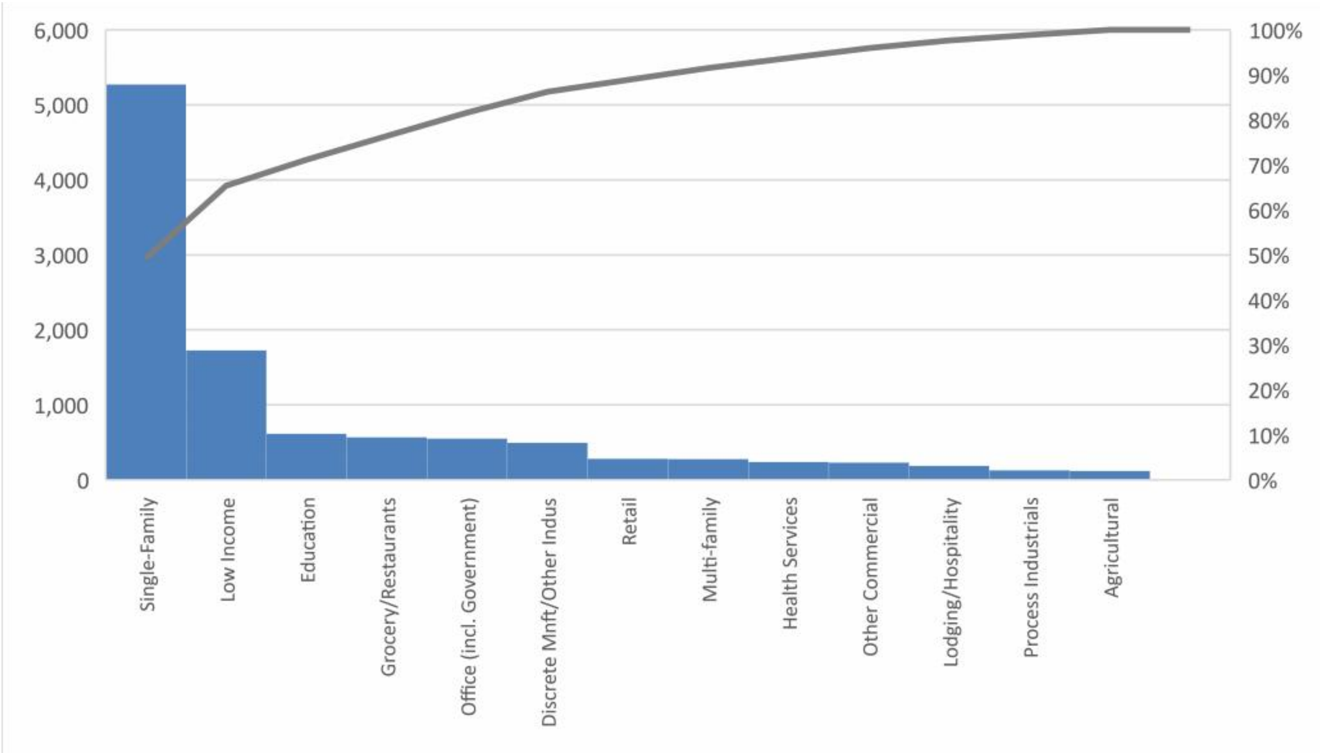
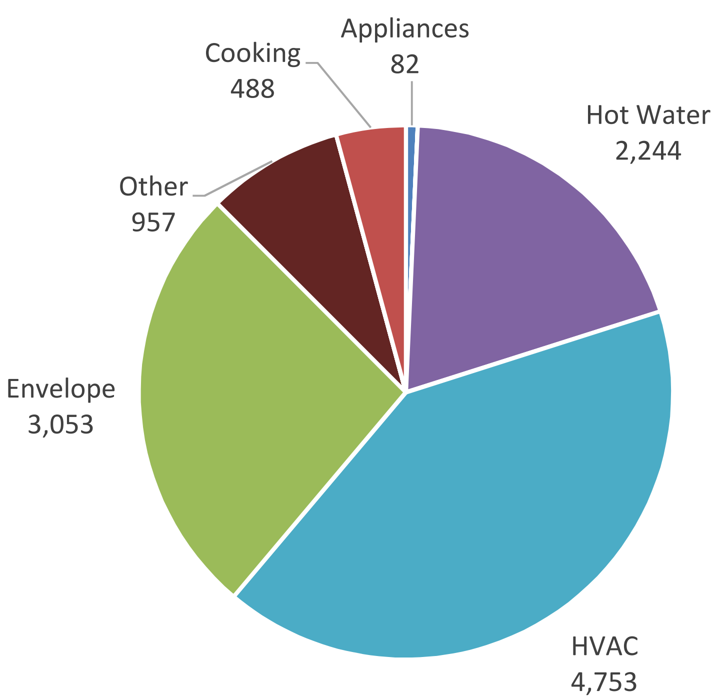


Figure 14: Total Gas Savings by End-Use (values in MDth)

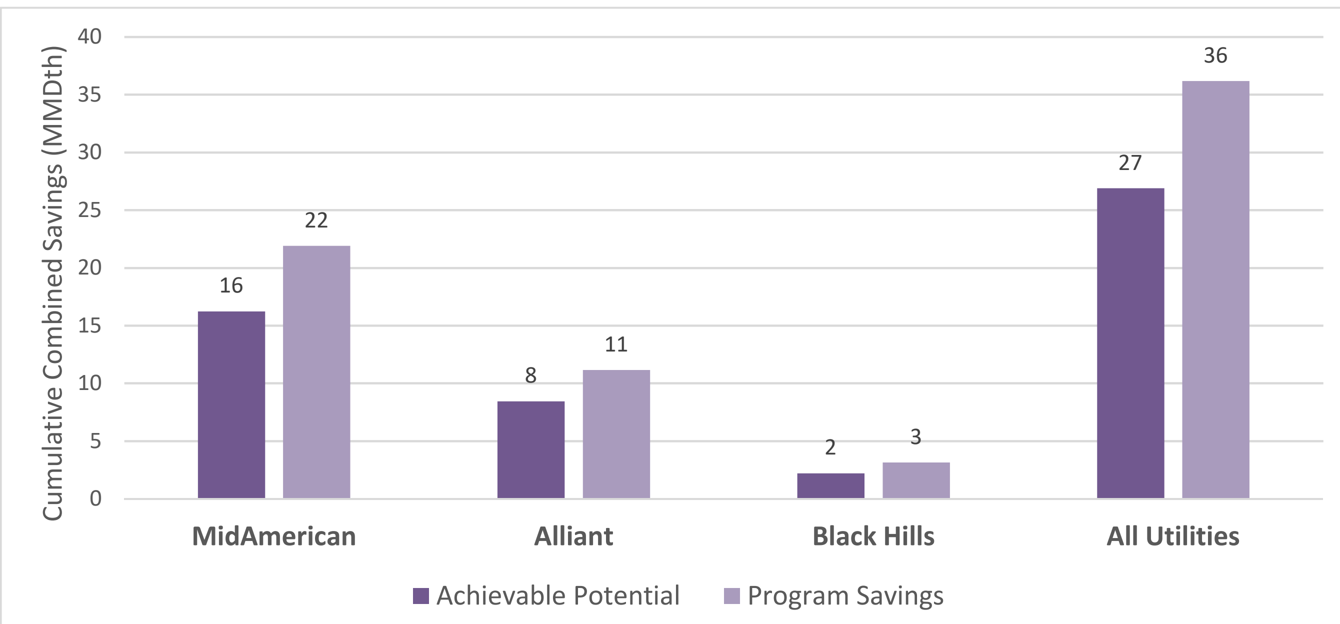


PROGRAM SAVINGS VS ACHIEVABLE POTENTIAL

The Achievable Potential represents the cumulative savings resulting from the efficiency measures and programs. However, for measures that have shorter than ten-year EULs, the same measure may be installed more than once over the study period. In these cases, the second installation would not contribute additional cumulative savings, since the opportunity was already accounted for in the first measure install. Conversely utility DSM program may provide an incentive for both installations, and therefore the savings would be reported as part of the program impacts for each instance. This leads to the following:

- **Program savings are greater than the achievable potential:** A significant portion of measures have EULs shorter than 10-years, and therefore the combined program savings are on average 34% greater than the achievable potential (as shown in Figure 15 below).
- **Cost per unit savings are calculated based on Program Savings in this report:** Calculating the cost per unit energy from program savings allows an apples-to-apples comparison of Iowa AOP Model program costs with current utility DSM program costs per unit savings.

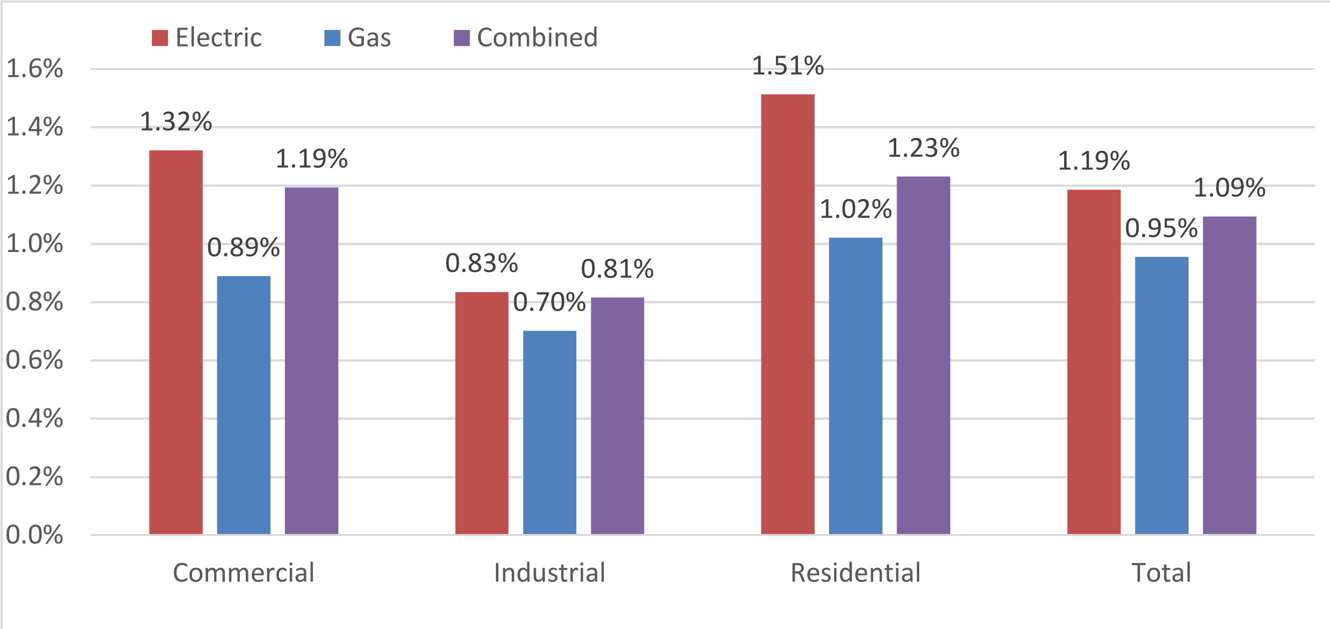
Figure 15: Comparison of 10-Year Cumulative Modelled Program Savings with Achievable Potentials



STRATEGIC CONSIDERATIONS

The Iowa AOP Study provides an assessment of the technical, economic and achievable potential for the three IUA member retail gas and electricity utilities: MidAmerican, Alliant and Black Hills. Based on the results presented in this study, the following strategic considerations emerge.

Figure 16: Annual Statewide Achievable Potential Savings as Portion of Base Sales



1. RESULTS ARE COMPARABLE TO OTHER STUDIES AND CURENT PROGRAMS

The AOP Study provides comparable achievable study results to past studies and programs.

- **The achievable potential is significantly higher than current annual program savings and spending:** When the current and achievable program savings are compared with the same NTGR applied, the achievable portfolio savings are 81% higher than current electric savings, and 114% greater than current utility program gas savings. These increased savings carry a 99% increase in program costs overall. Moreover, under that same conditions, the achievable portfolio cost per unit savings (i.e. per kWh or Dth) is comparable to current program cost per unit savings (ranging from 65 less than current program average costs for Alliant to 23% higher than current costs for Black Hills).
- **The results indicate a slight increase in the achievable potential compared to the 2012 Iowa AOP Study:** The achievable potentials expressed as portion of gas and electric sales are higher in this study that in the last statewide potential study conducted in 2012. When comparing under the same NTGR assumptions, the 10-year potential expressed in cumulative savings (GWh and MDth) have increased significantly compared to the 2012 study results, albeit at a significant increase in program cost.
- **Benchmarking the achievable potential portfolio savings indicated that they are comparable to other leading jurisdiction gas and electric program results:** Realizing the study's annual achievable portfolio savings would place Iowa utilities among the leading gas and electric portfolios in the nation. However, due to lower than the national average gas and electricity

prices in Iowa, Iowa utility cost per unit savings are significantly higher than the average reported in other jurisdictions for both electric and gas savings.

2. ACHIEVABLE PORTFOLIO SAVINGS ARE SUBSTANTIALLY GREATER THAN CURRENT UTILITY PROGRAM SAVINGS

The achievable potential measures cumulative savings over the 10-year period, while the AOP Study achievable portfolio savings accounts for savings from measures that may be counted in multiple program-years over the study period – e.g. such as DR measures and Home Energy Reports which each have 1-year EULs. Thus, the resulting achievable portfolio savings exceed the achievable potential savings by 33% in this study.

- **When applying the same NTGR, the 10-year average annual achievable portfolio savings are almost twice as large as current program savings:** By normalizing achievable portfolio with the current program reporting that applies a NTGR of 1 for all savings, we are able to compare the savings on an apples-to-apples basis. When applying a NTGR of 1, the statewide electric achievable portfolio is over 80% greater than the current program savings, and the statewide gas achievable portfolio is more than twice as large as current utility program savings.
- **Achievable portfolio costs are nearly double current program spending:** In both cases the cost per unit savings are nearly equivalent to current utility program costs per unit savings. Therefore, the increased achievable portfolio savings from this study's results would require significantly higher program budgets to achieve.

3. ELECTRICITY SAVINGS OPPORTUNITIES

The residential sector represents the highest savings opportunity both in terms of portion of base sales and in total achievable potential (GWh).

- **Single-family homes represent the highest opportunity:** with significant LED lighting savings potential (interior and exterior), along with AC and refrigerators and other HVAC and lighting applications.
- **The offices segment offers high electric savings:** stemming primarily from lighting (LED Low-Bay and linear fixtures), HVAC measures and other measures such as Retro-commissioning and EMS improvements.
- **The manufacturing industries collectively offer significant electric savings:** dominated by custom savings measures, as well as VFD/VSD drives, refrigeration, and lighting opportunities.

4. GAS SAVINGS OPORTUNITIES

As with the electric potential the residential market offers the greatest potential both in absolute and relative to base sales perspectives.

- **Single-family homes and low-income customers offer significant gas savings potential** stemming from furnace and envelope upgrades, advanced thermostats, and water heating savings. Together, these segments represent over 65% of the total statewide gas potential savings.
- **The offices, education facilities and groceries and restaurants represent significant gas savings opportunities**, primarily from commercial kitchen applications (ovens and fryers), space heating, and water heating.
- **The discrete manufacturing segment offers the majority of industrial sector gas savings,** with the large number of small and medium sized facilities in this sector offering significant space heating, water heating, and custom gas measure savings opportunities.

5. DEMAND REDUCTION

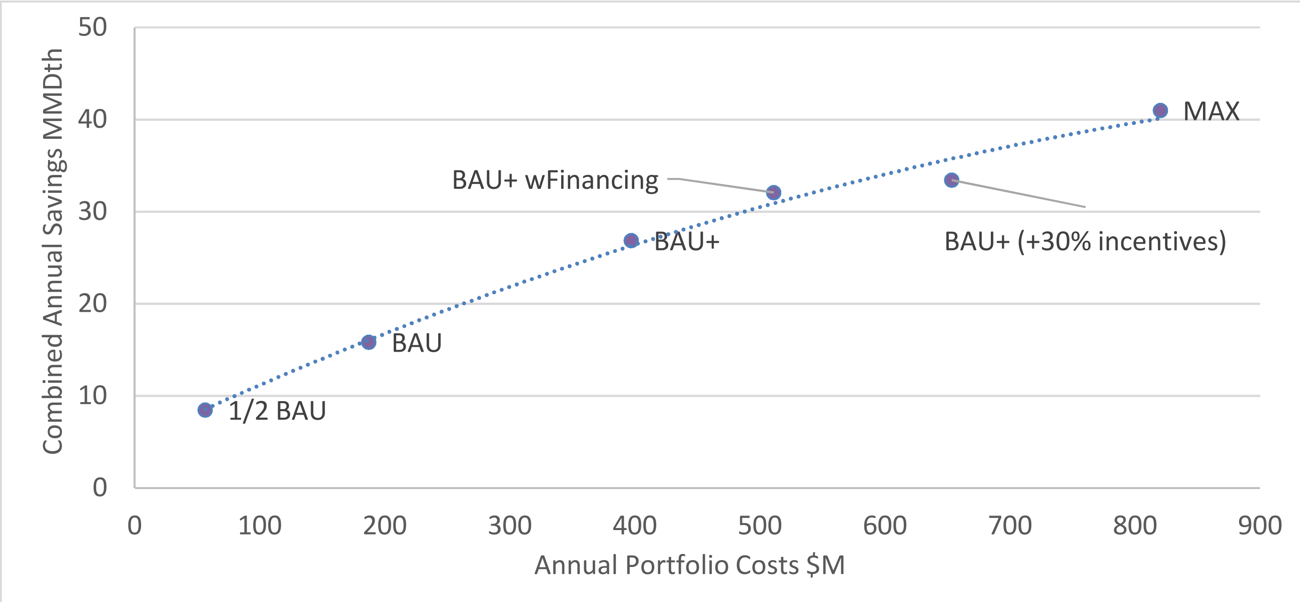
The AOP Study compared the demand reduction from the efficiency measures and

- **Gas demand reduction potential is somewhat lower than the consumption potential:** Gas peak demand savings result from the efficiency measure peak coincident use reduction. Concentrating program on measures with higher peak coincidence, such as envelope and HVAC measures could improve demand reduction results.
- **Electric demand reduction is initially driven by the DR programs, but in later years efficiency drive demand reduction begins to exceed DR program potential:** The model applied a conservative estimate to DR program growth. Testing higher incentive levels and program marketing could help the utilities to growth DR potential throughout the study period.

6. PROGRAM OPTIMIZATION WITH THE IOWA AOP MODEL - SCENARIO ANALYSIS TOOL

The Iowa AOP Model offers a scenario analysis tool that allows the utilities to test various program design configurations and assess the resulting savings, and portfolio cost-effectiveness. We tested a variety of program scenarios to identify key trends in the achievable results.

Figure 17: Combined Savings Under Various Incenitve Program Investment Scenarios



- **The marginal cost per unit savings rises as the overall program savings increase:** Figure 17 above shows the relationship between program savings and program costs under various achievable potential scenarios. As the savings increase, the programs must go after more expensive savings opportunities, thereby raising the program cost per unit savings achieved.

- **The AOP Model can be used to optimize program costs and savings:** The AOP Model allows program planners to rebalance programs and thereby focus marginal increases in portfolio savings on programs with the highest benefit/cost ratio. Finding portfolio designs that sit to the upper left of the trend line shown in Figure 17 indicates a portfolio design optimized to deliver higher savings at a lower cost per unit savings.

- **Financing can increase achievable savings significantly:** Achievable potential savings increase by up to 19% when the modeled financing programs are applied. The results indicate the financing has a larger proportional impact on longer EUL measures.

- **The combination of financing and incentive programs may deliver savings more cost-effectively than incentives alone would deliver:** Our results show that the marginal costs for additional savings under a financing + incentive approach was significantly less costly than achieving the same additional savings through incentives alone. Observing Figure 17 above, the BAU+ scenario with financing indeed sits slightly to the upper left of the portfolio savings-cost trend line, indicating that it represents an improved cost vs. savings profile compared to incentive only portfolios. Further exploration with the Iowa AOP Model could offer significant opportunities to optimize the use of financing and incentive programs in Iowa utility portfolios.

7. STUDY LIMITATIONS

While the Iowa AOP Study applied a rigorous approach to assessing the market baseline and modelling potential savings, the study limitations must be taken into account when considering the findings. It should be noted that consideration of the factors described in Table 3 could increase the gas and electric savings results.

Table 3: Study Limitations Impact of Assess Potentials

Type 1: Model Inputs/Settings	
Changing codes and standards	The EISA standards, along with many other federal standards may be at risk of not being enacted as planned under the federal administration's stated intention to lighten regulations. Removing these standards would increase the efficiency potential as baselines equipment efficiencies would not be raised through federal standards.
Residential new construction code compliance	The study relied on secondary sources to determine the impact of code compliance in residential new construction, and the assumptions applied were verified with relevant market actors.
Applied Iowa TRM Version 1 (2016)	Due to the timing of the study we applied the Iowa TRM Version 1 (2016) to characterize most of the measures in the model. Updates to the TRM in 2017 could impact program costs and savings if there are significant changes.
Future technologies	While the study included current commercially available technologies and emerging technologies, other unforeseen future technologies could become commercially viable over the study period that have unforeseen additional savings potentials.
Type 2: Sources of Additional Savings	
Non-utility programs	The Iowa AOP Study considered a full range of utility programs, but programs and policies initiated by state and local governments, and other local energy cooperatives could support further savings potential. Examples include state-lead-by-example initiatives, and home and building energy reporting and disclosure policies.
Non-utility financing	Only utility financing programs were considered. Other programs such as municipal PACE financing or lighting as a service financing could have further impacts on the achievable potential by reducing access to capital-related barriers.
Non-efficiency measures	The Iowa AOP Study did not include customer owner generation, battery storage or combined heat and power within the scope. These out of scope measures could have significant impacts on both demand and consumption potentials.

8. NEXT STEPS

The Iowa AOP Study is a key input into utility efficiency programming. Each of the utilities will be developing a 2019-2023 program plan in the coming months. The Iowa AOP Model offers unique functionality to test the program plans and portfolio design, test assumptions, and vary economic factors to compare program plan results to the assessed achievable potential.

1. INTRODUCTION

Dunsky Energy Consulting, in collaboration with its subcontractors Michaels Energy and Opinion Dynamics Corporation conducted an Assessment of Potential (AOP) study for the Iowa Utilities Association (IUA). The Iowa AOP Study quantifies the gas and electric energy efficiency potential from IUA-member utility demand side energy efficiency programs over the 2018-2027 timeframe.

The Iowa AOP Study entailed four key elements:

- **Market Baseline Study:** Extensive primary research that captured the penetration and saturation of key energy using equipment in a statistically representative sample of homes and business across the state.
- **Net-to-Gross Study:** In parallel to the Iowa AOP Study we conducted primary and secondary research into NTGR for current utility programs. The results of this study were applied in the AOP Model to assess the net achievable savings potential.
- **Utility Data Review:** A review and treatment of utility data and results from past programs and the Iowa Technical Reference Manual (TRM) to characterize market segments, efficiency measures and programs as well as perform base sale projections.
- **Iowa AOP Model Development and Delivery of Scenario Analysis Tool:** Dunsky's Potential Model was applied to construct a tailored Iowa AOP Model with a user-friendly interface. This tool is being delivered to the utilities and stakeholders as part of this study, and will be a valuable tool for performing scenario analysis for utility DSM program planning.

This report provides a high-level explanation of our study methods and modelling approach, as well an analysis of the statewide potential for utility programs over the study period.

1.1 CONTEXT: STATEWIDE ASSESSMENT OF POTENTIAL

The Iowa AOP Study captured statewide results by combining efficiency potentials across the three utility service territories. Customer data from each utility was used to establish primary data collection sample frames, and assess market segment consumption breakdowns by size and fuel.

For each utility, a unique set of model inputs was developed including:

- Measure by measure markets (number of efficiency opportunities)
- Economic factors such as discount rates, gas and electricity rates and avoided costs
- Efficiency program characterizations
- Baseline projected consumption and demand profiles by market sector

Measure savings and model calculation methods were then applied uniformly across each utilities' markets and the savings were rolled up into statewide totals. The Iowa AOP Report Volume 1 primarily presents the aggregate statewide findings, while utility specific results are provided in more detail in Volume 2.

This study was conducted for the Iowa Utilities Association on behalf of the three investor-owned gas and electric utilities:[3]

- **MidAmerican Energy Company (hereinafter referred to as MidAmerican):** MidAmerican, is headquartered in Des Moines, and is Iowa's largest energy company. MidAmerican Energy provides service to more than 734,000 electric customers and 714,000 natural gas customers in a 10,600-square mile area in Iowa, Illinois, South Dakota and Nebraska.
- **Alliant Energy (hereinafter referred to as Alliant):** has electric and natural gas utility operations serving customers in Iowa and Wisconsin. This report concerns Alliant's Iowa service territory where it operates through subsidiary Interstate Power and Light Company (IPL).
- **Black Hills Energy (hereinafter referred to as Black Hills):** Based in Rapid City, SD. the company serves 769,000 natural gas and electric utility customers in Colorado, Iowa, Kansas, Montana, Nebraska, South Dakota and Wyoming.

In each case, this study focuses exclusively on these utilities' Iowa service territories and customers.

[3] Source: http://www.iowautility.org/ (accessed on July 20, 2017)

1.2 DEFINITIONS

The Iowa AOP Study applied the definitions and rules contained within Iowa Administrative Code, Utilities Division, Chapter 35, ENERGY EFFICIENCY PLANNING AND COST REVIEW. Instructions for conducting an AOP Study for Iowa utilities is contained within Rule 199-35.8(476) *Assessment of potential and energy efficiency plan requirements.*

Relevant definitions from the Chapter 35 Rules are reproduced below:[4]

- **"Assessment of potential"** means development of energy and capacity savings available from actual and projected customer usage by cost-effectively applying commercially available technology and improved operating practices to energy-using equipment and buildings and considering market factors including, but not limited to, the effects of rate impacts, the need to capture lost opportunities, the nonenergy benefits of measures, uncertainty associated with industry restructuring, the strategic value of energy efficiency to the utility, and other market factors.
- **"Phase-in technical potential"** means the technical potential for energy and capacity savings from the adoption of commercially available technology and operating practices when existing equipment is replaced or new equipment is installed. For example, if an energy-using unit of equipment has a ten-year lifetime, the phase-in technical potential in any one year might be one-tenth of the total number of such units in existence plus units projected to be installed.
- **"Economic potential"** means the energy and capacity savings that result in future years when measures are adopted or applied by customers at the time it is economical to do so. For purposes of this chapter, economic potential may be determined by comparing the utility's avoided cost savings to the incremental cost of the measure.
- **"Benefit/cost tests"** means one of the four acceptable economic tests used to compare the present value of applicable benefits to the present value of applicable costs of an energy efficiency program or plan. The tests are the participant test, the ratepayer impact test, the societal test, and the utility cost test. A program or plan passes a benefit/cost test if the benefit/cost ratio is equal to or greater than one.
- **"Societal test"** means an economic test used to compare the present value of the benefits to the present value of the costs over the useful life of an energy efficiency measure or program from a societal perspective. Present values are calculated using a 12-month average of the 10-year and 30-year Treasury Bond rate as the discount rate. The average shall be calculated using the most recent 12 months at the time the utility calculates its benefit/cost tests for its energy efficiency plan in subrule 35.8(6). Benefits are the sum of the present values of the utility avoided supply and energy costs including the effects of externalities. Costs are the sum of the present values of utility program costs (excluding customer incentives), participant costs, and any increased utility supply costs for each year of the useful life of the measure or program. The calculation of utility avoided capacity and energy and increased utility supply costs must use the utility costing periods.

[4] Source: https://www.legis.iowa.gov/docs/iac/chapter/199.35.pdf (Access July 21, 2017)

- **"Energy efficiency measures"** means activities on the customers' side of the meter which reduce customers' energy use or demand including, but not limited to, end-use efficiency improvements; load control or load management; thermal energy storage; or pricing strategies.
- **"Incremental cost"** means the difference in the customer's cost between a less energy efficient measure and a more energy efficient measure.

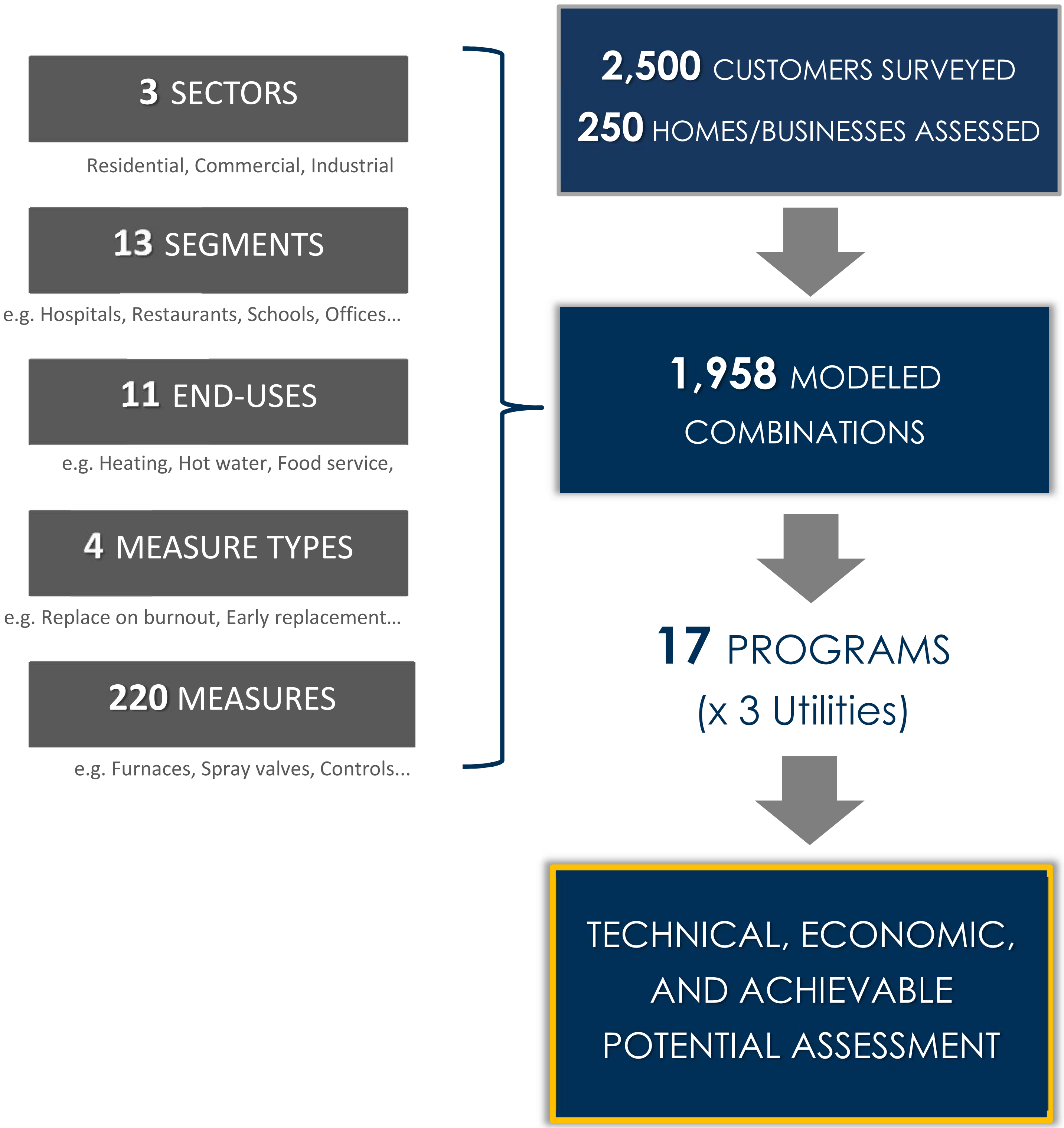
Other definitions of note include:

- **Low-Income:** the subset of utility customers that are income-eligible for assistance programs, as defined by the Iowa Low Income Home Energy Assistance (LIHEAP) definitions.[5]
- **Population:** populations are defined for each energy efficiency measure applied in the model, and are also referred to as the measure market. Both terms refer to the applicable number of buildings, units, or equipment capacity for a given energy efficiency measure installation, over the AOP Study period for a given utility.
- **Statewide:** refers to the total sum of all three utilities contributions to a given value. For instance, the statewide achievable electric potential is the sum of all three IUA member utilities' achievable electric potentials. It does not include the contributions of savings attributable to other utilities such as local cooperatives, however, if savings are attributable to the IUA utility program, but impacted a customer of another utility (e.g. for a Black Hills gas customer who has an electric account with a municipal coop electric utility) these savings are counted within the statewide totals.
- **Combined savings or costs:** refers to the total costs or savings from gas and electric potential savings assessments.

[5] LIHEAP eligibility can be found at: https://www.benefits.gov/benefits/benefit-details/1546

1.3 IOWA AOP STUDY SCOPE

The Iowa AOP Study applied a bottom-up model using inputs from a statistically representative market baseline assessment of energy using equipment in Iowa homes and businesses. This granularity supports a detailed approach to assessing each energy saving opportunity, providing AOP results based on the highest quality inputs.



The Iowa AOP Study divided the three utility customer bases into the market sectors and segments as presented in Table 4 below, and assessing the potential savings for each of the end-uses outlined in Table 5. We modeled the cumulative savings over the 2017-2028 period to arrive at the assessment of the technical, economic and achievable potential for each utility, and at a statewide basis (three utilities combined).

Table 4: Market Sectors and Segments Applied in Iowa AOP Study

	Sector	Segment
RESIDENTIAL MARKET	**Residential**	Single Family
		Multi-Family
		Low Income
NON-RESIDENTIAL MARKET	**Commercial**	Office (including Government)
		Retail
		Education
		Lodging and Hospitality
		Health Services
		Grocery and Restaurants
		Other Commercial
	Industrial	Agriculture
		Process Industrials
		Discrete Manufacturing and Other Industrial

Table 5: Energy End-Uses Applied in Iowa AOP Study

End-Use	Examples of Measures
Lighting	LED light bulbs, lighting controls, efficient linear lighting
HVAC	Thermostats, heat pumps, air conditioning units
Motors	Furnace fan motors, pool pumps, C&I ventilation & process motors
Refrigeration	Refrigerators, freezers, vending machine misers
Food Services	Ovens, dishwashers, fryers
Hot Water	Heat pump water heaters, low flow showerheads, spray rinse valves
Appliances	Clothes dryers
Products	Smart strips, TVs, Dehumidifiers
Behavior	Feedback, opt-In behavioral, basic educational measures
Envelope	Insulation, air sealing
Other	Retro-commissioning, advanced energy analytics, cable boxes

STUDY LIMITATIONS

While the Iowa AOP Study applied a rigorous approach to assessing the market baseline and modelling potential savings, the limitations of the study must be taken into account when considering the study findings. It should be noted that including consideration of the factors described in Table 6 could increase the gas and electric savings results

Table 6: Study Limitations Impact of Assess Potentials

Type 1: Model Inputs/Settings	
Changing codes and standards	The EISA standards, along with many other federal standards may be at risk of not being enacted as planned under the federal administration's stated intention to lighten regulations. Removing these standards would increase the efficiency potential as baselines equipment efficiencies would not be raised through federal standards.
Residential new construction code compliance	The study relied on secondary sources to determine the impact of code compliance in residential new construction, and the assumptions applied were verified with relevant market actors.
Applied Iowa TRM Version 1 (2016)	Due to the timing of the study we applied the Iowa TRM Version 1 (2016) to characterize most of the measures in the model. Updates to the TRM in 2017 could impact program costs and savings if there are significant changes.
Future technologies	While the study included current commercially available technologies and emerging technologies, other unforeseen future technologies could become commercially viable over the study period that have unforeseen additional savings potentials.
Type 2: Sources of Additional Savings	
Non-utility programs	The Iowa AOP Study considered a full range of utility programs, but programs and policies initiated by state and local governments, and other local energy cooperatives could support further savings potential. Examples include state-lead-by-example initiatives, and home and building energy reporting and disclosure policies.
Non-utility financing	Only utility financing programs were considered. Other programs such as municipal PACE financing or lighting as a service financing could have further impacts on the achievable potential by reducing access to capital-related barriers.
Non-efficiency measures	The Iowa AOP Study did not include customer owner generation, battery storage or combined heat and power within the scope. These out of scope measures could have significant impacts on both demand and consumption potentials.

1.4 REPORT STRUCTURE

The Iowa AOP Study contains two volumes, the first presenting the methods, findings and the AOP results primarily at the statewide level. A detailed set of model inputs and results tables is provided in Volume 2, including utility by utility results and more detailed results by market segment, which comprises the report Appendices. A brief guide to the report structure is outlined below.

VOLUME 1

Section 2 – Methodology: The report begins by outlining the methods applied to gather market baseline data, project the baseline consumption and demand and assess the energy and demand potentials through the Iowa AOP Model.

Section 3 - Model Inputs: We next provide details on the inputs used to populate the Iowa AOP Model and how they were derived. This includes our approach to characterize measures and utility DSM programs, as well as the economic inputs applied.

Section 4 – Assessment of Potential Results: The high-level potential results are presented, providing statewide results for the various scenarios tested, as well as select utility by utility results. This section also contains more detailed results at a sector, segment and end-use level.

Section 5 – Program and Scenario Analysis: A more detailed analysis of the achievable potential is then discussed, highlighting trends that may be relevant to DSM program planning. We also present a sensitivity analysis on key influencing factors and indicate areas where Iowa AOP Model can be applied to help optimize utility program planning.

Section 6 – Key Take-Aways and Findings: At the end of the report we recap the key findings and strategic considerations.

VOLUME 2

Appendices: A second volume to this study provides appendices containing detailed methodologies, market baseline study results, measure details, and model outputs for each utility. Within the text of Volume 1 the reader will find references to specific appendices where further relevant details are presented.

2. METHODOLOGY

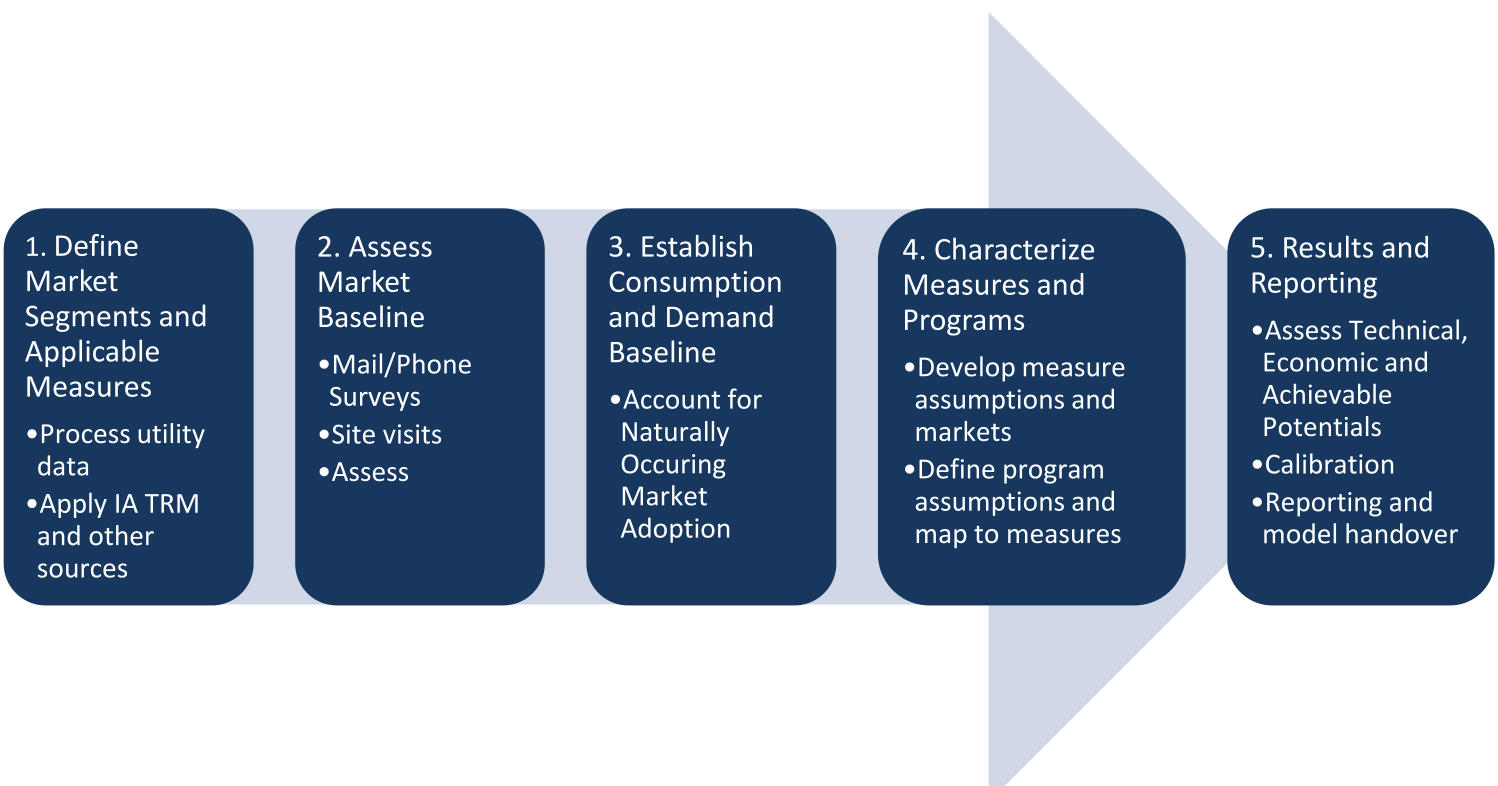
The Iowa AOP Study entails two key elements designed to assess the statewide gas and electric savings potentials over the 2018-2027 period:

Market Baseline Study: We conducted an in-depth market study to develop a statistically representative assessment of the penetration and saturation of energy using equipment across the three utilities' service territories. This Study entailed collecting building data through phone surveys, mail surveys and site visits to a statistically representative sample of Iowa homes and businesses in the later part of 2016 and early 2017. The Market Baseline Study anchors the AOP on Iowa-specific data, representing assessed market conditions across four sectors and 13 segments.

Iowa AOP Model: We developed and applied a potential model designed specifically to capture the energy and demand savings potentials for the three IUA utilities. This bottom-up potential model applies Iowa TRM measures, as well as additional commercially available measures and emerging technologies, to the market baseline conditions. The Iowa AOP Model is provided along with this report to the utilities and efficiency plan stakeholders to allow them to test various programming scenarios and update assumptions over the Study period.

In parallel to the Market Baseline Study, we also conducted a NTGR assessment of existing efficiency programs, through both primary and secondary research. This additional study was used to estimate program NTGR in the Iowa AOP Model, adding further precision to the net savings potential results.

Figure 18: Iowa AOP Study Steps



POTENTIAL LEVELS ASSESSED

The Iowa AOP Study assessed three levels of potential: technical potential, economic potential, and achievable potential. In each case, these levels were defined with respect to the requirements and definitions specified in Chapter 35, as follows:

- **Phase-in Technical Potential:** The technical potential accounts for all theoretically possible energy savings stemming from commercially available measures. In markets where multiple measures may compete,[6] the measure procuring the most energy savings per unit is selected. The technical potential is defined as the electricity or gas savings from these measures multiplied by the theoretical maximum number of units per year. It is phased in year-by-year based on the natural turnover of existing equipment, and a reasonable timeline for implementation of discretionary measures.
- **Economic Potential:** The economic potential includes all measures which pass the Iowa societal cost test (SCT) with a cost-benefit ratio of 1 or higher. Economic screening is performed at the measure level, and only accounts for measure costs and benefits, not including general DSM program costs. In cases where multiple measures may compete, the cost-effective measure offering the most savings per unit is included in the Economic Potential assessment.
- **Achievable Potential Scenarios:** The achievable potential is defined as the potential savings stemming from the best-in-class efficiency and demand response programs. Market shares of measures competing with each other within a given market are pro-rated using the respective measures adoption rates. The Iowa AOP Study assessed the achievable potential under three scenarios, as described in Table 7 below

Further details on how the Iowa AOP Model assessed the above levels of potential are contained in the following sections. This includes an overview of the Market Baseline Study methods, a summary of how the consumption baseline was established, and finally, the computational approaches applied within the Iowa AOP Model. Chapter 3 presents details on the model inputs, including how energy efficiency measures and programs were characterized.

[6] We use the words "market" or "market size" to describe the number of baseline equipment or buildings in a given segment that capture the opportunity for specific energy-efficient measures. For example, the number of sockets with incandescent bulbs in the single-family residential sector would be an example of a "market" for CFLs or LEDs.

MODELED SCENARIOS

In order to assess the impact of utility DSM programming settings on the achievable potential, a range of scenarios were developed, as presented in Table 7 below.

Table 7: Achievable Potential Scenarios Applied in the Iowa AOP Study

Scenario Name	Scenario Conditions
Business as Usual (BAU)	DSM programs are characterized using currently reported utility incentive and administrative costs and cost effectiveness screening is applied at the measure level for program eligibility.
Business as Usual *Plus* (BAU+)	DSM programs are characterized with a 25% increase in administrative costs to account for improved marketing and delivery to reduce customer barriers. Incentives are set at current levels, except in a few strategic cases where the best in class programs suggest higher incentives are appropriate. Measures are screened for cost-effectiveness such that the resulting programs and portfolios maintain SCT values equal to or greater than one, except where otherwise specified (e.g. Low-Income programs). Further details are presented Appendix H: DSM Program Characterization Details.
Maximum Achievable	Applies the same conditions as in the BAU+ scenario, but with incentives set at 100% for all programs.
Financing Programs	Financing programs can be applied as an adder to any of the AOP Model scenarios, by engaging the Financing toggle on the AOP Model dashboard. Our analysis focused on the impact of including financing and incentive programs under the BAU+ case, but the scenario analysis AOP Model allows the user to assess the impact of financing under any of the incentive portfolio scenarios.

2.1 MARKET BASELINE STUDY – PRIMARY DATA COLLECTION

An in-depth Market-Baseline Study of the Iowa Residential and Non-Residential markets was conducted as a foundational element of the Iowa AOP Study. By collecting primary data on the penetration and saturation of energy using equipment and quantifying the opportunities to apply energy efficiency measures in the various market sectors and segments, the Market Baseline Study was key to ensuring that the AOP was based on real Iowa conditions and data, rather than assumptions drawn from other jurisdictions. The following sections outline the approach taken to conduct the study, and further details are provided in Appendix C: Market Baseline Study Detailed Methodology.

PRIMARY DATA COLLECTION: RESIDENTIAL SECTOR

The primary data collection activities for the residential sector included a mail survey that yielded 1,540 customer responses and in-home visits at 100 homes. The mail survey and home visit sample sizes were designed to achieve a statistical representative sample of residential properties in Iowa. While the mail-survey offered a much larger number of responses, the home visits were performed by experts who were trained to recognize and assess equipment specifications. The home visits were therefore used to verify any ambiguities in the mail survey data and provide a deeper technical assessment of each home.

Figure 19: Residential Sector Primary Data Collection Steps

The residential primary data collection sought to determine the penetration and saturation of energy using equipment and efficiency opportunities among three residential customer segments:

- **Single Family (SF)** – Includes homes with up to four units or apartments
- **Multi-Family (MF)** – Includes residential buildings with five or more apartments or units
- **Low-Income** – Includes single family or multi-family homes wherein the residents qualify as income-eligible for low-income programs

The following sections provide a summary of the residential sector primary data collection activities, further details are provided in Appendix C: Market Baseline Study Detailed Methodology. These results were then used to formulate the market baseline and applicable populations for efficiency measures applied in the Iowa AOP Model.

RESIDENTIAL MAIL SURVEY

The 2016 Iowa Statewide Residential Energy Use Survey consisted of a mail/internet survey of residential customers of the three Iowa utilities. The study included both market rate and low-income customers and both single family and multifamily homes with each of those segments. We designed the mail survey to collect comprehensive penetration and saturation data on energy-using equipment as well as information about the customers and their homes.

As of August 2016, there were 1,073,075 unique households with active accounts among the three utilities. Customers in Iowa may receive their electric service from Alliant Energy, MidAmerican Energy, or a municipal utility or cooperative. Similarly, customers may receive their gas service from Black Hills Energy, Alliant Energy, MidAmerican Energy, a municipal utility or cooperative, or may not have gas service. The options available for each customer for electric and gas service depend on the customer's location and how it relates to the competing utilities' service territories. Table 8 shows the breakout of residential customers (i.e., households) for each utility. Note that because the study team only had customer information from the three utilities, we did not have visibility into customers who are not customers of at least one of the utilities.

Table 8. Number of Unique Active Residential Customers (Households) Among Iowa Utilities

Gas Utility / Electric Utility	Alliant	Black Hills	MidAmerican	None or No Info.[7]	Total
Alliant	125,795	50,838	72,444	137,993	387,070
MidAmerican	11,849	33,278	318,244	122,583	485,954
No Information[8]	55,783	90,233	54,035	0	200,051
Total	**193,427**	**174,349**	**444,723**	**260,576**	**1,073,075**

The target number of completed surveys was 1,000. To achieve this number, we sent out 5,000 survey booklets, assuming a response rate of approximately 20%. The sampling approach was a random sample for market rate customers (including both single family and multifamily) and low-income customers (including both single family and multifamily). We did not stratify the sample by single family and multifamily homes, and instead allowed a proportional number of completed surveys to fall into these segments. Note that we oversampled low-income homes to ensure a sufficient number of responses to represent that group adequately in the overall estimates.

Overall, we received 1,550 responses to the survey: 1,379 by mail and 171 via the internet. Of these, 10 responses were duplicates. Removing these ineligible responses resulted in a total of 1,540 usable responses.

[7] This column refers to IUA utility electricity customers who have no gas service, or for which no information on who provides their gas service was included in the provided utility account data.

[8] This column refers to IUA utility gas customers for which there is no information on who provides electricity service. This includes utility gas customers who use obtain electricity from local cooperatives.

Overall, 6% of mailed surveys were undeliverable. The resulting response rate, calculated as the number of completed surveys divided by the number of deliverable surveys, was 29%. Given this higher than expected response rate, we greatly exceeded the target number of completes in all three segments. Table 9 below summarizes these survey statistics.

Table 9: Mail Survey Residential Sample Weights

Segment	Population		Responses		Sample
	Count	%	Count	%	Weight
Market Rate Single Family	694,550	73.5%	1,024	66.5%	1.1053
Market Rate Multifamily	116,123	12.3%	97	6.3%	1.9509
Low Income	134,364	14.2%	419	27.2%	0.5226
Total	945,040	100%	1,540	100%	

RESIDENTIAL IN-HOME VISITS

We conducted a total of 100 in-home visits with residential customers of the three utilities, including 70 market-rate and 30 low-income customers in January and February 2017. The in-home visits were designed to collect data to verify mail survey responses and to collect additional, more technical data (such as equipment capacity or efficiency ratings) that we did not include in the mail survey as customers generally find it difficult to report. The sampling approach was a random sample within each of these segments. The in-home visits were designed as a nested sample, drawing the sample of homes from the population of mail survey respondents.

Table 10: Types of Information Collected in Residential Site Visits

Housing type and Occupancy	Penetration and Saturation of Major End Uses	Equipment Characteristics	Behavior
Seasonal occupancy **Building age** **Square footage (above ground and basement)** **Type of home** **Occupant demographics**	Lighting HVAC equipment Major appliances Water heating Linear feet of HVAC ductwork inside and outside envelope Envelope characteristics	Equipment type Nameplate information Power draw (W) Efficiency rating ENERGY STAR status	Number of occupants Lighting habits Equipment use habits Control strategies employed (e.g. programmable thermostats etc.)

To ensure that the mail/internet survey results are representative of the utility's population of customers, we developed and applied sample weights. Details on the applied sample weights can be found in Appendix C: Market Baseline Study Detailed Methodology.

Table 11: Site Visit Residential Sample Weights

Segment	Population		Respondents	
	Count	Portion	Count	Portion
Market Rate Single Family	694,550	73.5%	63	63.0%
Market Rate Multifamily	116,123	12.3%	7	7.0%
Low Income	134,364	14.2%	30	30.0%
Total	945,040	100%	100	100%

PRIMARY DATA COLLECTION: COMMERCIAL AND INDUSTRIAL SECTORS (NON-RESIDENTIAL ACCOUNTS)

The primary data collection activities for the non-residential sectors included a telephone survey with 972 customers in the commercial and industrial sectors and on-site audits at a nested sample of 150 of these businesses.

Figure 20: Non-Residential Customer Primary Data Collection Steps

The telephone survey primarily gathered high-level penetration information on energy-using equipment and information on barriers to energy efficiency and participation in the utility's energy efficiency programs. The site visits collected more detailed information about the equipment, including penetration, saturation, efficiency, and end use specific information such as wattage, heating/cooling capacity, and horsepower. We used the combined data from these two sources to characterize penetration and saturation of energy efficiency equipment in the C&I sector and estimate potential.

The non-residential customers were classified into two sectors, collectively comprising ten business segments. Within each of these, we used utility data to stratify the customers by their annual gas and electricity consumptions. This allowed us to classify businesses by their function and size when assessing the applicability of measures to each segment population. The ten non-residential customer segments were applied in the Iowa AOP Model, with populations and measure savings established for combination of measure-business segment.

The primary objective of the sample design was to have a large enough pool of completed phone interviews to recruit site visit participants and to have a distribution of business segments and usage to enable us to aggregate findings to the sector level.

C&I SEGMENT CLASSIFICATION

We established 10 business segments based on discussions with the utilities and our review of their customer data. Alliant Energy and MidAmerican Energy provided segment classifications for all Iowa non-residential premises. Although we did not use these segments to develop the sample, we sought to complete surveys with a sufficient share of businesses in each business segment (to ensure that the overall results adequately represented the mix of business segments in Iowa). We therefore set quotas for each business segment in each usage stratum. However, given the low number of premises in some of the segments, we were unable to meet the quotas for all segments. In order to maximize the total number of responses, we conducted a census attempt of all businesses in highest electric and gas usage categories. We then weighted the results of the completed surveys and site visits back to the population (as described in Appendix C: Market Baseline Study Detailed Methodology).

Table 12: Iowa Potential Study Non-Residential Segments

Segment	Electric		Gas*	
	Portion of Premises with Electric Accounts (N=109,436)	Portion of Non-Residential Consumption	Portion of Premises with Gas accounts (N=71,836)	Portion of Non-Residential Consumption
Commercial Sector				
Office**	31%	21%	32%	25%
Retail	10%	6%	14%	9%
Education	6%	7%	8%	10%
Grocery/Restaurant	6%	6%	9%	10%
Lodging	2%	2%	2%	4%
Health/Hospital	3%	5%	5%	8%
Other Commercial	15%	1%	14%	9%
Commercial Sector Subtotal	***73%***	***49%***	***85%***	***74%***
Industrial Sector				
Agricultural	15%	3%	3%	3%
Process Manufacturing	1%	32%	1%	6%
Discrete Manufacturing	11%	16%	11%	17%
Industrial Sector Subtotal	***27%***	***51%***	***15%***	***26%***
Non-Residential TOTAL	**100%**	**100%**	**100%**	**100%**

* Exclude transport gas customers

** Includes Office and Government Buildings

TELEPHONE SURVEY

The telephone survey collected:

- High-level penetration information on energy-using equipment and building characteristics,
- information about customers' decision-making and barriers to purchasing energy-using equipment, and;
- firmographic information, including hours of operation.

The survey was aimed at building owners, business managers, and facility managers with knowledge of energy-using equipment at the premise. To maintain a reasonable length and to reduce the likelihood of collecting inaccurate information, the survey only asked high level penetration questions that respondents could be expected to be able to answer over the phone.

We implemented the survey through our call center between December 16, 2016 and February 23, 2017, and completed 972 interviews. We also used the telephone survey to recruit a subset of survey respondents for on-site audits which were conducted later.

Using extracts of customer data provided by the utilities, we identified 211,679 customer accounts among the three utilities, which we consolidated to 163,048 unique premises. A portion of these premises (17%) were out of scope for this study (e.g., communication towers and street lighting) or had very low or missing usage data. These records were excluded from the sample frame, resulting in a final frame of 135,185 non-residential premises.

Table 13. Number of Unique Active Non-Residential Customers (Business Premises) Among Iowa Utilities

Gas Utility / Electric Utility	Alliant	Black Hills	MidAmerican	None or No Info.	Total
Alliant	11,214	3,185	4,274	34,143	52,816
MidAmerican	1,064	1,472	27,663	26,707	56,906
No Info.	6,347	10,645	8,471	0	25,463
Total	**18,625**	**15,302**	**40,408**	**60,850**	**135,185**

The primary objective of the sample design was to have a large enough pool of completed phone interviews to recruit site visit participants and to have a distribution of business segments and sizes to enable us to report findings at the segment level. We stratified our sample by energy use rather than conducting a simple random sample because we sought to oversample premises with high usage to collect information on energy-using equipment typically only found in large facilities, and to assure that these types of facilities were adequately represented in overall estimates. For example, chillers are typically only found in large facilities and to collect enough information on this type of equipment, we needed to oversample large facilities (i.e., those with usage over 5,000 MWh/year). Table 14 shows the number of premises in the sample frame by stratum and the targeted number of phone interviews and site visits.

Table 14. Non-Residential Sample Frame and Expected Completes by Usage Category

Usage Range	Premises in Sample Frame	Targeted Number of Interviews	Targeted Number of Site Visits
Electric			
≥ 5000 MWh/year	435	131	58
150-5000 MWh/year	10,199	331	45
<150 MWh/year	98,802	138	17
Total	***109,436***	***600***	***120***
Gas			
> 200,000 therms/year	411	123	57
5,000 – 200,000 therms/year	12,360	263	31
<5,000 therms/year	61,173	89	7
Total	***73,944***	***475***	***95***

Note: Gas sample frame includes 2,108 transport customers later removed from the analysis

SITE VISITS

The 150 on-site audits were designed to collect data to verify the telephone survey responses and to collect more detailed and technical data that customers are generally unable to report on during a telephone survey. Our team of qualified technicians conducted the site audits in January and February 2017. They entered facility data using tablet computers and a comprehensive Excel-based data collection instrument. The data collection instrument covered the topics listed in Table 15.

Table 15: Types of Information Collected in Non-Residential Site Visits

Business and Occupancy	Penetration and Saturation of Major End Uses	Equipment Characteristics	Operations / Behavior
- Seasonal occupancy - Building age - Square footage (facility and occupied) - Conditioned space	- Lighting - Cooling - Heating - Ventilation - Refrigeration - Water heating - Motors, fans and pumps - Compressed air - Office equipment - Food service equipment - Agricultural equipment - Wastewater treatment equipment	- Equipment type - Nameplate information - Lighting wattage - Efficiency rating - ENERGY STAR status - Efficient and inefficient components	- Monthly, weekly, and daily operation - Lighting hours-of-use - Equipment hours-of-use - Control strategies employed (lighting: automation, EMS, programmable thermostats etc.)

PRIMARY DATA COLLECTION RESULTS

The primary data collection in the residential and non-residential markets allows us to determine the penetration and saturation of key energy-using equipment in homes and businesses. These were then used as inputs to the Measure Characterization process, in which the population of a given measure was estimated as well as the expected energy savings.

These two concepts are defined as follows:

- **Penetration:** A percentage representing the portion of customers that have one or more of a particular piece of equipment. It is calculated by dividing the number of customers with one or more of a piece of equipment by the total number of customers responding to that question. For example, market rate single family customers had a programmable thermostat penetration rate of 69%, compared to only 41% of market rate multifamily customers and 43% of low income customers.

- **Saturation**: A number representing how many of a particular piece of equipment exist, on average, among all customers. It is calculated by dividing the total number of a particular piece of equipment by the total number of customers responding to that question (regardless of whether they reported having the equipment or not). This ratio is at least equal to, but generally higher than, the corresponding penetration of the equipment, because some customers will have more than one of the equipment. For example, the saturation rate of programmable thermostats in market rate single family homes is 0.74 thermostats on average across all market rate single family homes, compared to an average of 0.41 across all market rate multifamily homes and 0.44 across all low-income homes.

Summary tables of the Penetration and Saturation (P&S) results can be found in Appendix D: Summary of Penetration and Saturation Results. Detailed results tables broken down by business consumption and market segment were provided separately to the utilities as part of the AOP Study report supporting documentation.

2.2 CONSUMPTION AND DEMAND BASELINE PROJECTION

The consumption and demand baseline projection is used to benchmark the effectiveness of an energy efficiency and demand response program portfolio over time. The baseline is also used to generate metrics and perform model calibration. Using data provided by the utilities, Dunsky developed the consumption and demand baseline for the AOP potential model.

MODEL FORECAST ADJUSTMENTS AND ACHIEVABLE BASELINE PREPARATION

The consumption and demand baseline is calculated using gas and electric sales forecasts provided each the utilities. The forecasts included the effects of naturally occurring savings (e.g. codes and standard changes) as well as projected program savings. Using details provided by the utilities, we adjusted the baseline to remove the impact of future program savings, but leaving in place the impacts of naturally occurring savings by applying the following methods:

- Where applicable, Dunsky removed sectors from the raw forecasts that were not included in the potential model, such as the public authority (including streetlights) and transport sectors.
- When T&D losses were removed from the original forecasts, Dunsky reintegrated them. This is because the model removes T&D losses in its calculation engine when reporting savings at generator. It also adjusts At Generator savings up to account for this modification.
- The following naturally occurring adjustments were explicit in Alliant's forecast: Lighting Standards, AC Standards, Customer Owned Generation, and Electric Vehicles. Dunsky removed these standards adjustments from Alliant's electricity forecast. If the standards impacted measures in the model (such as lighting measures) they were reintegrated at the measure level. Other standards not explicitly included in the forecasts (such as furnaces) were also later added into the model. The standards outside of the model scope (such as EVs) were removed.
- Assuming that these standards affect MidAmerican's electric consumption similarly, we converted these adjustments to percentages based on total utility consumption and applied these percent reductions to MidAmerican's forecasts.
- The utilities provided forecasts with implicit energy efficiency reductions. We removed the efficiency program savings from the predicted load, using the average energy efficiency as a portion of sales from the latest utility-specific energy efficiency plan or, in the case of Alliant, internal data. This step provided us with forecasts excluding energy efficiency programs.
- Naturally occurring energy savings contained within projected program savings were calculated by applying the NTG values from the NTG study to the gross program energy savings projections.
- By subtracting the net program savings from the overall projected sales, we arrived at a baseline sale projection that included the impacts of naturally occurring savings (both within and outside of the programs).

2.3 IOWA ASSESSMENT OF POTENTIAL (AOP) MODEL

The Dunsky Team tailored our user-friendly, transparent and adjustable potential model, creating the Iowa AOP Model to assess the electricity and natural gas energy saving potentials for each of the three Iowa utilities.

Three models were created, one covering each utilities' customer base, and the characteristics were established with respect to measure inputs, equipment saturation, and measure adoption assumptions, as well as all economic and related parameters. The model captures electricity and gas savings, assessing the consumption and demand reduction potentials over the 2018-2027 period (10-year potentials). The model outputs provide disaggregation of the results at various levels, including separation of the gas and electricity potentials as well as disaggregation by sector, program type, end-use and measure.

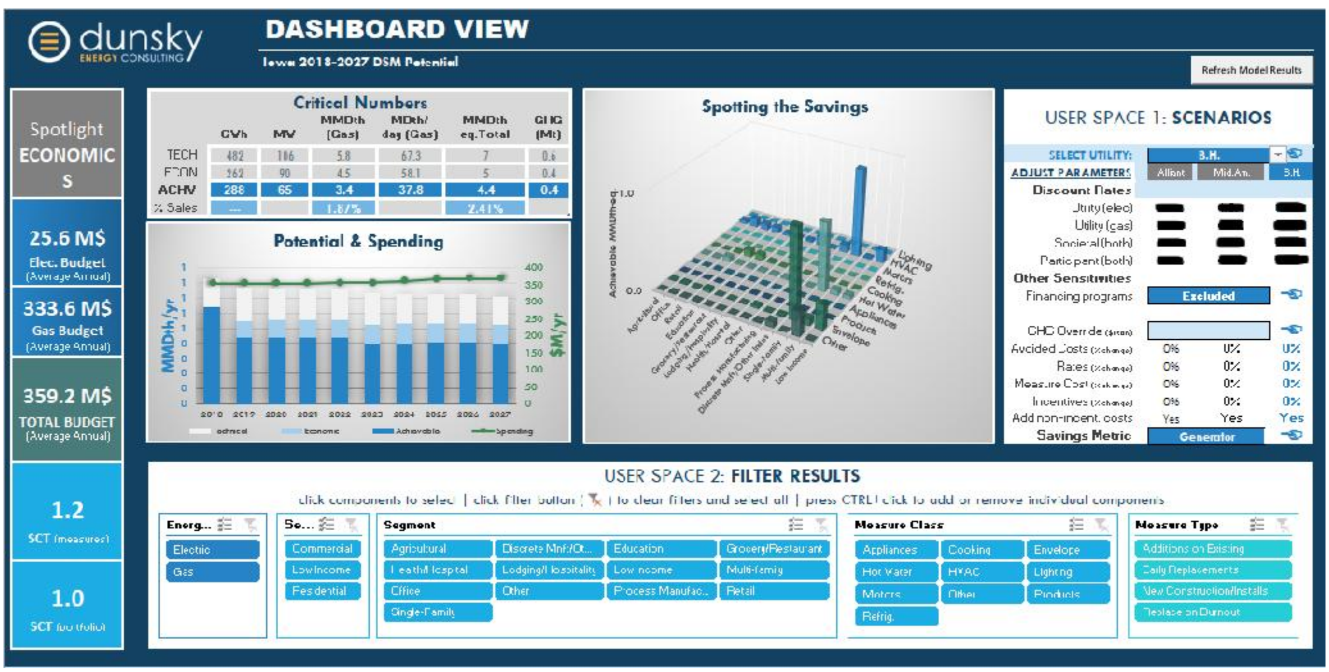
IOWA AOP SCENARIO ANALYSIS MODEL

Accompanying this Final Report, we have provided the utilities and other identified stakeholders with access and a license to the Iowa AOP Scenario Analysis Model. This is populated with the BAU+ scenario settings throughout the model, and can be adapted and adjusted to assess the potential resulting from various other programming and market settings.

The model includes the study's assumptions and full Technical, Economic and Achievable (BAU+) potential scenario results, and has been calibrated for each utility.

Figure 21 shows a snapshot of the dashboard, which is the main entry point to use the model's features, run sensitivity analyses, and get high-level results.

Figure 21: Iowa AOP Model – Dashboard View

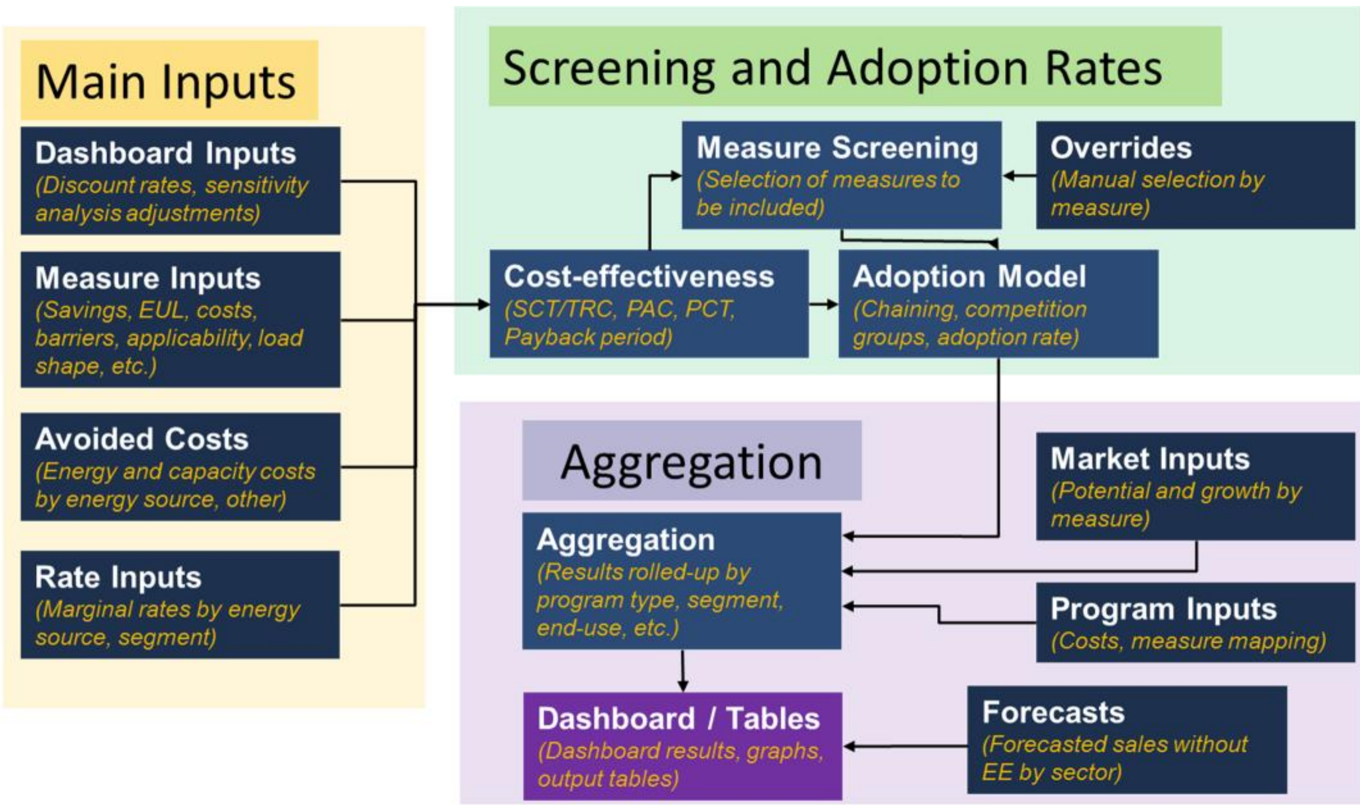


The user also has access to measure and program input and output tables. Core input assumptions in the model are clearly defined and can be easily changed to conduct sensitivity analysis, and adjust to changing market conditions (e.g. energy prices, economic growth) as well as recent program and evaluation results.

BOTTOM-UP AOP MODEL CALCULATIONS

Figure 22 presents the general model structure, including inputs (dark blue boxes), calculations (light blue boxes), and output tables (purple). The model uses a bottom-up approach, starting at the measure level. Based on measure inputs, the model screens measures and calculates adoption rates based on cost-effectiveness results. Measure results are then rolled-up by program type, segment, sector, energy source, and end-use.

Figure 22: General AOP Model Structure



KEY CALCULATION FEATURES

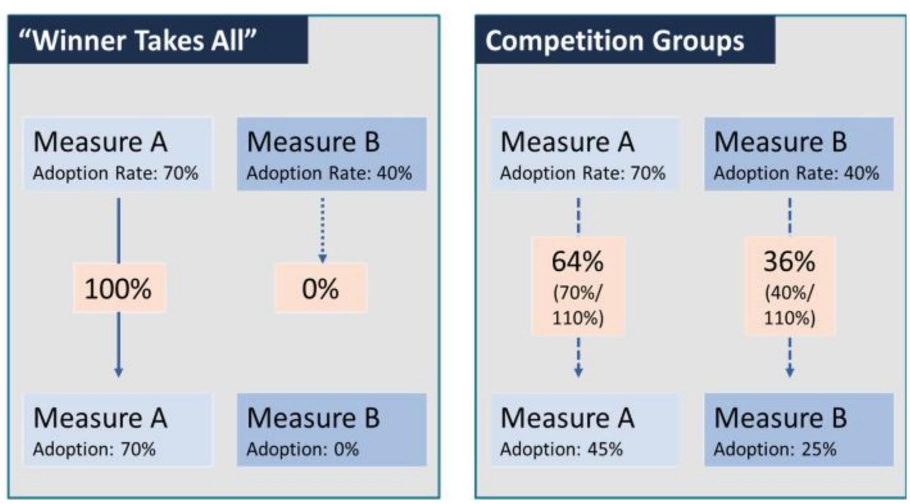
Key concepts used in the AOP model are briefly described below. A more in-depth description of the AOP model calculations and method are presented in Appendix A: Detailed Potential Model Description.

- **Model Inputs**: The model applies several inputs at the measure level (e.g., energy and capacity savings, costs, effective useful life, net-to-gross factors, load profile, etc.), as well as other inputs such as avoided costs, rates, electricity forecasts, markets, and DSM programs.
- **Units per Year (theoretical maximum phase-in potentials)**: Using inputs and calculations such as market size and growth, measure type, and natural replacement rates of existing equipment, the maximum number of units that could be replaced or installed for a given measure is calculated. The potential

model applies each utilities' specific avoided costs and customer base to calculate the technical, economic and achievable potentials for consumption and demand. Phase-in potentials are then calculated based on measure types and replacement schedules or market growth, as outlined in the following sections.

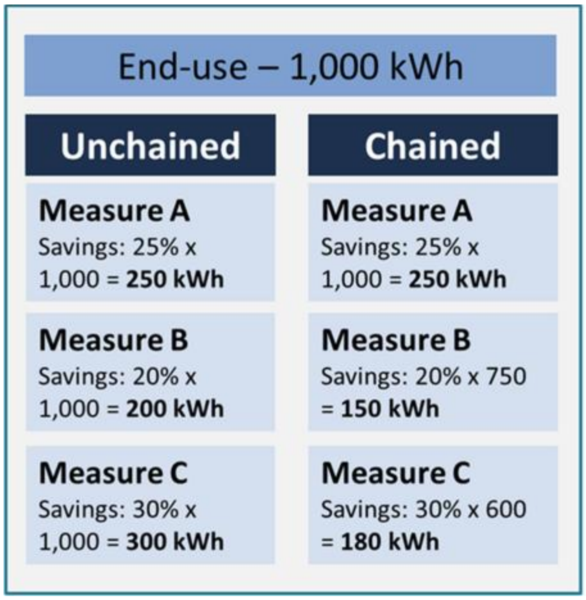
- **Cost-Effectiveness Screens**: The model calculates cost-effectiveness ratios at the measure level to screen measures. Cost effectiveness test values can also be obtained at the program and portfolio level.
    - The **Societal Cost Test (SCT)** is used to screen measures for the economic and achievable potentials. A positive SCT result (NPV higher than zero or cost-benefit ratio higher than one) indicates that the energy efficiency measure (or program) will produce reductions in energy costs, as well as non-energy benefits, that are greater than the costs of implementing that measure (or program).
    - The **Participant Cost Test (PCT)** is an input for measure adoption rates. A positive PCT result means that the participant of an energy efficiency initiative will receive benefits – including energy bill savings and non-energy benefits – that are higher than net costs (i.e., the cost of the measure minus incentives received by the participant). The higher the PCT ratio, the higher the adoption rate is, all else being equal. In very rare cases, measures with PCT ratios of less than 1 are screened out of the achievable potential.
- **Adoption Curves:** The base adoption rate for determining the achievable potential is calculated using the cost-effectiveness of measures from the participants' point of view (applying either the participant cost test for non-residential customers or the simple payback period for residential customers) and applying levels the adoption curve corresponding to the applicable market barrier level. The adoptions curves have short and long-term values that can be adjusted to account for (1) short-term limitations in adoption due lack of awareness and the existing program delivery structure, and (2) long-term opportunities because some market barriers can be reduced over time as a result of program strategies being put in place.
- **Competing Measures**: At the achievable potential level, multiple cost-effective measures can compete with each other for the same market (e.g. standard LED and CFL bulbs). In that case, each measure is attributed a share of the overall market, based on its base adoption rate compared to other measures. At the Technical and Economic Potential levels, a winner takes all approach is applied wherein the most efficient applicable technology takes the full market.

Figure 23: Competition Group Treatment in the AOP Model



- **Chained Measures:** Chained measures are measures that have their savings adjusted when other measures are installed first. For example, savings from lighting controls are lower when chained with efficient lamps, as compared to being chained with the baseline technology. The model calculates the chaining adjustment based on the likelihood that measures will be installed concurrently (determined by their respective adoption rates).

Figure 24: Chained and Competing Measures Example



Measure	Market Share	Savings
A alone	30%	250 kWh
B alone	20%	200 kWh
A and B	20%	400 kWh
None	30%	0 kWh

- **Cumulative Annual Savings**: Cumulative savings are calculated for each potential type and each year, using incremental savings potentials. Savings from individual measures are removed from the cumulative savings at the end of their effective useful life (EUL). For instance, a measure installed in Year 1 and with a EUL of two years would not be recounted in the cumulative potential starting in Year 3.

- **Aggregate Results and Reporting**: Measure-level consumption and demand savings-related costs, and benefits are aggregated and can be displayed by sector, segment, end-use, measure-type, or program. Costs are reported from both the program administrator's (program spending) and the service territory's (SCT) perspectives. The program administrator's costs do not include the participants' share of costs (i.e., costs that are not covered by incentives), nor do they include any adjustments for early retirement measure costs.

APPLICATION OF MEASURE SCREENING AND ADOPTION IN THE AOP MODEL

The AOP model applies various screening methods to determine the technical, economic and achievable potentials. These include screens based on each measure's specific characterization (cost-effectiveness, market applicability), as well as interactive and competition effects among measures.

For each level of potential assessment, a description of the screens applied is presented below.

- **Measures comprise those that are commercially available in Iowa**, using the finally approved measure list.
- **Competition:** The most efficient measure takes the full market among competing measures (e.g. measures that can apply to the same opportunities such as CFL and LED standard screw-in bulbs)
- **Chaining:** Chaining adjustments are applied to measures that interact with each other.

- **Cost-Effectiveness Screening:** Social Cost Test (SCT) applied at the measure level (not including program costs)
    - **Benefits:** Utility avoided costs, Non-energy benefit (NEB) adders (7.5% for gas and 10% for electricity), Non-Gas or Electricity Resource Savings (Water, Oil, Propane, O&M)
    - **Costs:** Measure incremental costs, other costs (e.g., O&M)
- **Competition:** Among competing measures, the cost-effective measure that provides the most savings per unit (electricity and gas combined) is selected within the Economic Potential
- **Chaining:** Chaining adjustments are applied to measures that interact with each other.

- **Market Adoption:** Participant Costs Test (PCT) applied along with Market Adoption curves pertaining to the assigned market barrier level for each measure
- **Competition:** Competing measures share the market according to their relative calculated adoption rates (as explained above and in the appendices)**.**
- **Chaining:** Chaining adjustments are applied to measures that interact with each other.
- **Net-to-Gross Ratio (NTGR):** The NTGRs are applied to each measure-program combination based on the accompanying NTGR Study conducted by the Dunsky Team in parallel to the AOP study.[9]

---

[9] Iowa Gas and Electricity Potential Study, Net-to-Gross Research, Final Report, Opinion Dynamics Corporation, 2017

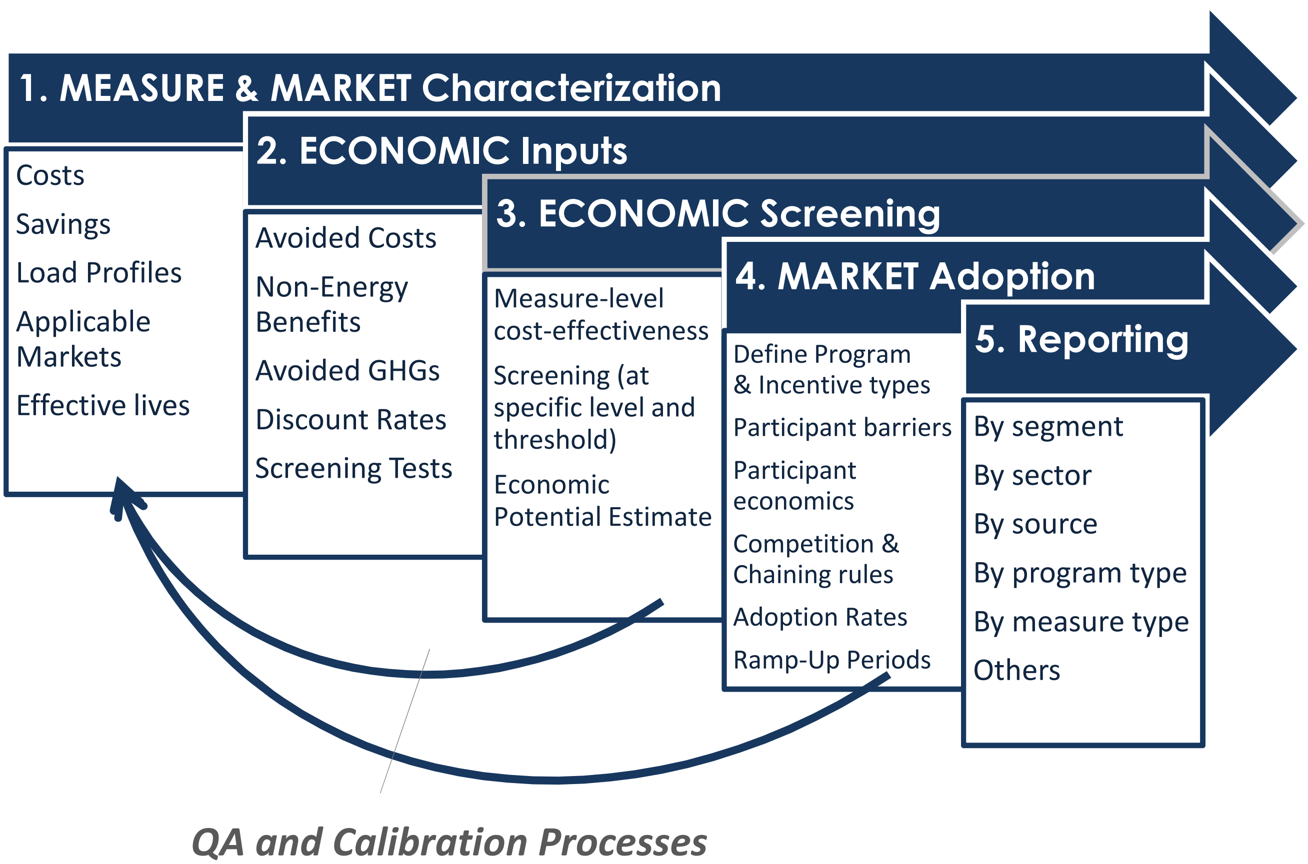
Table 16: Hierarchy of measure screening and adoption calculations at each level of potential assessment

CALCULATION STEPS	TECHNICAL POTENTIAL	ECONOMIC POTENTIAL	ACHIEVABLE POTENTIAL
6. ECONOMIC SCREENING	No Screen	Cost-Effectiveness (SCT)	Cost-Effectiveness (SCT and PCT)
7. MARKET BARRIERS	No Barriers (100% Adoption)	No Barriers (100% Adoption)	Market Barriers (Adoption Curves)
8. COMPETING MEASURES	Winner takes all	Winner takes all	Competition Groups
9. CUMULATIVE MEASURES	Chaining Adjustment	Chaining Adjustment	Chaining Adjustment
10. NET SAVINGS	Not Considered	Not Considered	Program NTGR

2.4 IOWA AOP MODELING PROCESS

The Iowa AOP Model applied a multi-step process to arrive at the assessed Technical, Economic and Achievable Potentials. At each step, the model precision was improved through a detailed review of the model results, and comparison to key benchmarks such as total segment by segment consumption data, current program savings (in total and by technology), the Market Baseline Study results, Iowa TRM details, and professional judgment. As a final step, the model inputs and results were provided to the utilities to review and compare to their own programming data, and to ensure that the model captured the utility data correctly.

Figure 25: Iowa AOP Model Development and Reporting Processes



MODEL CALIBRATION

Model calibration ensures that the overall estimated energy and demand savings levels are in line with utility electricity forecasts. For this study, because of the amount and quality of primary data, model calibration is not as critical as for other potential studies that must rely on secondary sources to make broad assumptions on equipment saturation and building characteristics. The comprehensive primary data on penetration, saturation, and characteristics of equipment and buildings in each sector and segment greatly reduces the chance of underestimating or overestimating the load forecast because the modeled baseline does not fit the actual baseline and real consumption.

In the residential and low-income sectors, we assessed measure savings relative to estimated heating and cooling loads and benchmarked results to projected consumption by segment, using account data to ensure that our overall estimated savings matches the electricity and gas forecast for these sectors. In the C&I sector, this approach would be too onerous due to the complexity and diversity of equipment and buildings. As both the potential markets and the baseline equipment were well defined through the primary research, those elements were not deemed critical. We therefore used indirect approaches, such as verification of furnace/boiler capacities by total gas consumption distributions among segments, and making high-level adjustments as deemed appropriate.

DELIVERY OF STUDY TOOLS

This Final Report captures and presents the Iowa AOP Model results under the defined scenarios.

- **Iowa AOP Model for Scenario Analysis:** A scenario analysis version of the Iowa AOP Model has also been made available to the utilities and the efficiency program stakeholders to test scenarios and update results to reflect changing market and economic conditions over the study period.
- **Detailed Penetration and Saturation Results:** Detailed Penetration and Saturation tables have been provided to the utilities capturing the detailed results of the Market Baseline Study.
- **Net-to-Gross Study:** Finally, in parallel to the AOP Study, we conducted research into the NTGR applicable to current Iowa Utility programs. This study was delivered to the utilities in June 2017.

3. IOWA AOP MODEL INPUTS

The Iowa AOP Model was populated with Iowa-specific inputs to create a representative tool that captures the range and extent of gas and electric saving opportunities in the utility service territories.

Key inputs include:

- **Utility Economic data**: including rate projections, avoided costs of generation and supply, discount rates, inflation rates, number, type and stratified average consumption of customers, DSM program activities and impacts.
- **Characterized Energy Saving Measures:** including measure costs (full and incremental), energy savings per unit, assumed market barrier level, market growth, replacement schedule, estimated life, applicable segments and populations, among others.
- **Best-in-Class Program Characteristics:** including details on residential and C&I sector DSM programs covering retrofit and new construction approaches, demand response programs, and a residential behavioral program.
- **Special Programs:** including details on Low-Income, Tree Planting and Code-Compliance programs, as required under the Chapter 35 rules.
- **Financing Program Characteristics:** Details on the application of five utility delivered efficiency financing programs covering whole home retrofits, residential general measures, municipal, university, schools and hospitals (MUSH) financing, small businesses and large business.

The following chapter provides an overview of the methods applied to characterize the full range of model inputs developed for the Iowa AOP Study.

3.1 UTILITY DATA

Over the course of the project development, the three utilities provided various data through a series of data requests. At the highest level, the data were used for the baseline and NTG study, model inputs and calibration. The Table 17 below details the majority of the data requested from each utility and a short description of how they were applied to the model.

Table 17: Summary of Utility Data Provided

Data Provided	Principle Use
Avoided Energy Costs	Provided for electricity and gas consumption and demand. In addition, we received winter and summer on and off-peak electricity avoided costs. Since the model requires 50 years of avoided costs, future years were extrapolated as necessary. The avoided costs are a principle component of the economic measure screening. Where necessary, hourly and monthly utility avoided costs were averaged to arrive at seasonal and annual values for modelling purposes.
Discount Rates	Each utility applies its own assumed discount rates based on their internal economics and assessment of their customer base.[10] These were applied to perform present value analysis of DSM investments and savings, which are a key model inputs for measure screening. Dunsky received the following discount rates: utility (for both fuel types), societal, and participant rates from the utilities. In addition, we received the assumed inflation rate.
Customer Data	Each Utility provided detailed consumption, billing and demand data from residential and non-residential customer. These were used to determine appropriate market segmentation and stratify the segments by annual electric and gas consumption for the market baseline.
DSM programs	Detailed descriptions, forecasts, and results from existing DSM programs were provided from each utility, as outlined in their 2014-2018 Efficiency Program Plans and recent Efficiency Program Annual reports. These were used in the program characterization development.
Measure Assumptions	Any documentation of measure assumptions, including the Iowa TRM, program evaluation reports and other relevant data. The measure assumptions were used primarily in the measure characterization development.

[10] All discount rates applied in the model are Real discount rates. Where nominal discount rates were provided by the utilities, they were converted to real discount rates by removing the utility provided inflation rate.

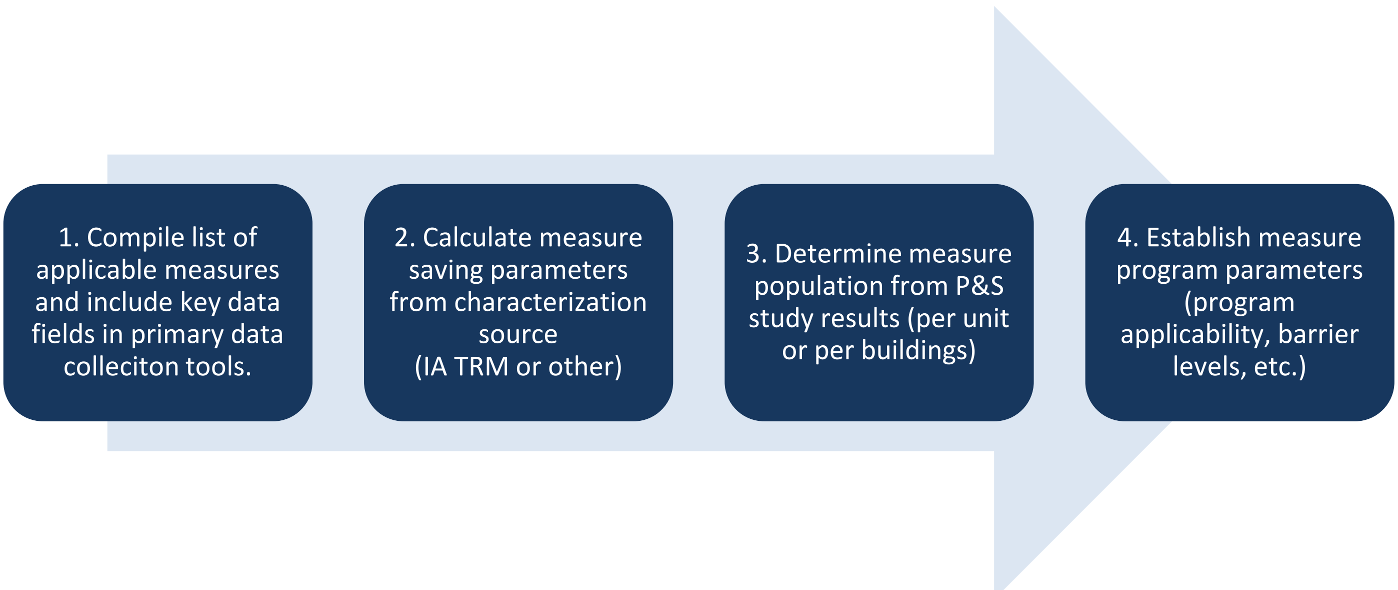
Data Provided	Principle Use
Energy Forecasts	Each utility provided their 2018-2027 energy and demand forecast for their gas and electrical services (as relevant). These forecasts included T&D Line Loss Factors, and other program and natural adjustments. Where possible, the utilities provided the expected baseline energy efficiency savings reductions by year, sector/segment, energy source, and their major underlying assumptions. The forecasts were used principally to assess the impact of energy and demand savings on utility sales.
Financing Program Materials	Financing program descriptions, design, costs, customer data and implementation plans were provided for each of the utilities' residential equipment financing programs. In addition, the utilities provided program evaluation reports and data on the financing programs. The financing data were used for financing program characterization.
Marginal Rates	Energy billing rates were defined for each market segment. These were used for calculating achievable potential. To calculate energy billing rates, we collected rate structure from the utility documentation. For each sector and segment, the most appropriate rate and rate block was selected based on rate definition/structure and customer characteristics (e.g., average consumption). Those rates are added to the gas avoided cost assumptions within the model to calculate the total customer bill impacts.

3.2 ENERGY SAVING MEASURES

The Iowa AOP Model includes 1,958 measure-market combinations, representing the full range of commercially available technologies (current and emerging). The included measures were characterized primarily using the Iowa TRM in conjunction with the Market Baseline Study results to determine the population of energy saving opportunities for each measure, and the current baseline technology mix.

Using a list of measures approved by the utilities and stakeholders, we applied the measure characterization process steps outlined in Figure 26 below.

Figure 26: Measure Characterization Steps



MEASURE CHARACTERIZATION

A list of measures was presented to the AOP Oversight Committee early in the project, based largely on the list of measures in the Iowa TRM Version 1[11]. This list was expanded and adapted based on feedback from the utilities and stakeholders, as well as additional measures (representing emerging technologies and markets in Iowa, as well as custom measures) provided by Dunsky, and a final approved measure list was compiled.

A list of measures that appear in the Iowa AOP Model but are not included in the Iowa TRM is presented in Table 18 below. A full list of measures characterized and details on the assumptions applied to characterize these measures are presented in Appendix F: Measure Characterization Details.

---

[11] Iowa Energy Efficiency Statewide Technical Reference Manual, August 1, 2016 (as Filed with the Iowa Utilities Board on September 30, 2016, EEP-2012-0001)

Table 18: Measures included in the Iowa AOP Study that are not in the Iowa TRM Version 1

Residential Market	Non-Residential Market
• Room Air Cleaner • Dehumidifier • Drain Water Heat Recovery • Linear LED Lamps (Emerging Tech) • Efficient Pool Pumps (Emerging Tech) • Home Energy Reports (Behavioral) • Residential Demand Response • Ceiling Fan (Emerging Tech) • Occupancy Sensors Interior (Emerging Tech) • Occupancy Sensors Exterior • Code Compliance (Special Program Measure) • Tree Planting (Special Program Measure)	• High Efficiency Ventilation Hoods • Smart Thermostats (Emerging Tech) • Demand Control Ventilation (Emerging Tech) • Dual Enthalpy Economizer (Emerging Tech) • Boiler Tube Inserts • Evaporator Fan Controls (Emerging Tech) • Motorized Dampers • Process Boilers • Stand-Alone Refrigerators and Freezers • Retro-Commissioning and Strategic Energy Management (SEM) • Energy Recovery Ventilator (Emerging Tech) • Tree Planting (Special Program Measure) • Custom commercial, industrial and refrigeration measures

MEASURE TYPES AND REPLACEMENT SCHEDULES

The model uses four types of measures: replacement on burnout (ROB), early retirement (ER), addition (ADD), and new construction/installation (NEW). Each of these measure types requires a different approach for determining the maximum yearly units available for potential calculations, as detailed in Table 19.

For ROB measures, the number of existing equipment in a given year (after applying growth rates) is divided by the effective useful life (EUL) of the measure, to get a theoretical maximum number of units per year, which is further adjusted to account for factors such as technical constraints (applicability factor), competition groups, and market adoption rates. In cases where there is a significant difference between the baseline EUL and the efficient technology EUL, the former is specified in the model and used for unit per year calculations. The units are spread minimally over the 10 years of the study to get impacts during each year of the study; this rule affects measures with short EULs, as well as measures that can be implemented at any given point in time (insulation, controls). For some measures/markets, such as New Construction, the number of units per year is specified directly in the model. Table 19 below provides a guide as to how each measure type is defined and how the replacement or installation schedule is applied within the Iowa AOP Model to assess the phase-in potentials, year by year.

Table 19: Measures Types and Schedules Applied in the Iowa AOP Model

Measure Type	Description	Market Base	Yearly Units Calculation
Replace on Burnout (ROB)	Existing units are replaced by efficient units after they fail *Example: Replacing incandescent bulbs by LEDs*	Existing Units	Market/Effective Useful Life (EUL) *The EUL is set at a minimum of 10 years to spread installations over the potential study period. Alternative EULs can be used to calculate yearly units if baseline units have a different EUL than efficient units.*
Early Replacement (ER)	Existing units are replaced by efficient units before burnout *Example: Early replacement of functional but inefficient refrigerators*	Existing (Old) Units	Market (old units)/10 years (study period) *The market is defined as the number of subset of the total number of existing units (e.g., old refrigerators that could be retired early)*
Addition (ADD)	An EE measure is applied to existing equipment or structures *Example: Adding controls to existing lighting systems, adding insulation to existing buildings*	Existing Units	Market/10 years (study period)
NEW	Measures not related to existing equipment *Example: Installing a heat-pump in a newly constructed building.*	Custom	Market *Market base is measure-specific and defined as new units per year*

NEW CONSTRUCTION MEASURE MARKETS

Markets are largely determined by our primary data collection. The surveys and site visits collected existing equipment and building characteristics across the three utility service territories.

For new construction measures and markets, we applied the following approaches:

Residential Market: New construction market populations were estimated from Census Bureau data[12] for Iowa. We calculated the average number of single family and multi-family units constructed per year using the published data for the previous 3-year period (2014, 2015 and 2016). Since the census bureau does not indicate whether the constructed units are for Low Income or Non-Low Income, we assumed that the low-income segment is contained within these statistics.

Non-Residential Market: The non-residential new construction market was extrapolated from building characteristics data obtained in the Market Baseline study, projecting the growth rate over the past 10-years forward.

MEASURE FIELDS

For each measure included in the model, a range of specific fields were defined for entry into the model. These covered the following categories

- **Applicable segment and sector:** Including the relevant rate class, sector and segment tags
- **Measure population:** number of buildings, equipment units (e.g. fans) or size units (e.g. HP of Compressors)
- **Measure descriptions:** Including baseline technology (or technology mix) and efficient technology description
- **Measure annual gross savings:** per unit electric and gas savings, including consumption and demand values, as well as non-resource savings (O&M, water, propane, heating oil etc.).
- **Measure types**: For each measure, the installation timing relative to the EUL of the existing equipment is defined by the following:
  - Replace on Burnout (ROB)
  - Early Replacement (ER)
  - New or Additional Measures (ADD)
  - New Construction (NEW)
- **Measure costs:** incremental and full costs (where available)
- **Measure life:** EULs measure and baseline technology (where ER is applicable)
- **Measure adoption factors:** including market applicability factors and assigned barrier levels
- **Load factors:** including summer and winter peak coincidence factors, and seasonal savings distributions

For each measure, an assessment was made regarding the quality of the market data used to determine the measure population (low, medium or high) such that the model output can provide a measure of level of

[12] Source: https://www.census.gov/construction/bps/stateannual.html (accessed March 2017)

certainty behind the mix of savings under efficiency programming various scenarios. In general, the market data was of high quality if a breakdown of P&S data was available for each applicable segment.

Fields are determined for each measure-segment combination, and the program factors are applied such that each measure is allocated to various programs. A detailed list of measure inputs is found in Appendix J: AOP Study Measure Input.

Dual Baseline Measures: Several measures were characterized using a dual baseline approach, falling into two categories:

- ER measures applied the current technology as the baseline for the remainder of the existing technology's useful life, after which the measure baseline as defined in the Iowa TRM (or other relevant source) was applied.
- ROB measures where the equipment standards are expected to change during the AOP period and measure EUL, specifically these were related to lighting measures that are expected to be impacted by the new Efficiency Independence and Security Act (EISA) of 2007, when it comes into force in 2020. In these cases, the measures applied the current baseline efficiency for the initial period, and the new standard baseline efficiency after the standards take force. These are tagged as ROB-D measures in the AOP model. While it is recognized that the EISA standards may not ultimately be adopted, the Iowa AOP Oversight Committee instructed the study team to include the EISA standards until further notice.

UPDATED CODES AND STANDARDS

Over the course of the study, a number of new codes and standards will come into force. In some cases, these impact the efficiency of the baseline equipment, and there by can reduce the savings potential for the effected measures. We considered all relevant codes and standards updated that were approved by May 1, 2017, based on information available on the Appliance Standards Awareness Project and Department of Energy websites. The following table outline the codes and standards considered and applied within the study.

Table 20: Codes and Standards adjustments included in AOP study

Measure/Standard	Compliance Date	Impacts
EISA Lighting	2021	Reduced lighting savings in al markets: **improved baseline applied in model.**
Residential Clothes Washers	2018	Improved baseline for top loading washers: minor impact on residential clothes washer savings – not-included due to negligible impact on overall model results
Dehumidifiers	2019	New baseline matches measure baseline from TRM
Furnace fans	2019	Electric savings from gas furnace improvements to be eliminated after 2019 – **improved baseline applied in model.**
Ceiling Fans	2020	New standard baseline unit's specification in CFM/W – unclear if or how this may impact baseline performance – not included in model
Boilers (res)	2021	Boilers are used in 2% of homes, negligible impact from baseline improvement, therefor not included in model.
Pool pumps	2021	Negligible impact on electric savings (less than 0.2%) **pool pumps should be removed as a program measure post 2021**
New Construction (IECC 2018)	2021	**Reduced savings built into model** for non-residential New Construction measures post 2021
Automatic Ice Maker (non-res)	2018	New baseline no more efficient than baseline applied in TRM
Commercial CAC and HP	2023	1% impact on HVAC electric savings, in later years of study period. Assumed that new CEE tiers will likely be updated as well, so not included in the model.
Commercial Furnaces	2023	New baseline no better than baseline used in measure characterization (AFUE 0.85)
Pre-Rinse Spray Valves (PRSV)	2019	Negligible impact on savings (less than 0.1 GWh or 0.01 MMDth). PRSV should be removed as a program measure post 2021
Pumps	2020	Impacts not deemed to have significant impact on overall VFD and process motor measures
Vending Machines	2019	New standards pertain to testing procedures. Impact on baseline (if any) is unclear. Not included in model.

3.3 DEMAND SIDE MANAGEMENT PROGRAMS

The Iowa AOP Model applies a set of "best in class" DSM program bundles that are characterized by their applicable market coverage, incentive levels and administrative costs. The program bundles (detailed in Table 21, Table 22 and Table 23 below) were developed based on current utility programs in Iowa, the Chapter 35 "special programs" and utility program models from other jurisdictions that fit the best in class definition. With these bundles defined, Dunsky created a methodology to allocate current Iowa program data to the bundles. With these allocations, we created baseline inputs with which the program scenarios were defined. The set of defined fields for each program bundle characterization is presented in the Appendix G: DSM Program Characterization Details.

PROGRAM CHARACTERIZATION METHODOLOGY

In the Iowa AOP Model, the bundled DSM programs are characterized for each individual utility to account for differences among their DSM portfolios. Each program bundle was characterized following a series of steps to ensure methodological consistency across programs. As a first step, to create the BAU scenarios, data was gathered on the programs itself. The primary data source was from the 2014-2018 utility energy efficiency plans. From these plans, Dunsky extracted expected program costs and savings. Then these data were applied to the best in class programs using the programming mapping schema. The mapping schema is presented in Appendix H. Where one Iowa program applied to more than one program bundle, its costs and savings were split proportionately between each bundle.

Figure 27: Program Characterization Steps

Each program has five inputs that were characterized based on data that was received from the utilities and adjusted to reflect findings from a review of a jurisdictional scan of 42 best in class programs from five utilities. The Program characterization fields defined for each bundle are listed below:

- **Fixed Administration Costs were defined as program costs that did not change with the potential model measure uptake.** We assumed that 75% of the M&V costs, 75% of advertising costs, and 50% of administration costs fell under fixed costs. The costs were then mapped from the utilities energy efficiency plans onto the best in class program characterizations for the BAU scenario. For the BAU+ scenario, we assumed a 25% increase in costs from the BAU scenario. For the MAX scenario, we assumed a 50% increase in costs from the BAU scenario.
- **Variable Administration Costs were defined as program costs that did change with the potential model measure uptake.** Based on a review of utility program plans and annual reports, we assumed that 25% of the M&V costs, 25% of advertising costs, and 50% of administration costs fell under variable costs. The costs were then mapped from the utilities energy efficiency plans onto the best in class program characterizations for the BAU scenario. For the BAU+ scenario, we assumed a 25% increase in costs from the BAU scenario. For the MAX scenario, we assumed a 50% increase in costs from the BAU scenario.
- **Incentive levels are the portion of measure incremental costs that are paid to program participants by the utility.** These were varied by scenario to assess the ability for higher incentive levels to drive program participation. For example, under the BAU scenario, incentive levels were set to current Iowa utility incentive levels. For the BAU+ scenario we assumed a minimum incentive level of 50% for C&I, 75% for residential, and 100% for low-income. For the MAX scenario, we assumed 100% incentive for all programs.[13]
- **Barrier Reductions refer to the ability of programs to reduced market barriers through effective marketing and program delivery.** Since energy efficiency programs tend to increase their effectiveness and have growing market effects over time, the Iowa AOP Model splits this indicator into two five-year periods (2018-2023 and 2024-2028). For the BAU+ scenario, we counted the number of barriers that were being addressed by each program. From the count, we assigned a basic barrier reduction level. We then revised these assumptions using a combination of professional judgement and experience from other projects. As a result, the barriers were set at a half and full barrier steps in the first and second period respectively for most programs. For the MAX scenario, we assumed a further half step barrier reduction for the programs
- **The Cost-Effectiveness Threshold indicates the minimum SCT value for which a measure can be included in the program**. This can be lowered to allow non-cost-effective measures to pass into the program for cases where CE screening is done at the program or portfolio level rather than the measure level. For the BAU+ scenario the CE thresholds applied were set to 0.5 as a default to emulate cost-effective screening at the program rather than measure level. For any program that resulted in an overall SCT of less than 1.0, the CE threshold was raised to ensure program cost-effectiveness was achieved. The "special programs" from Chapter 35 and Demand Response programs are the exception, where no screening was applied by setting the SCT at 0. For the MAX scenario, we kept the default CE ratio of 0.5

[13] The Alliant Interruptible Demand Response program is an exception, as it applies an incentive level that is higher than 100% of the incremental customer cost. This is a model work-around required to adapt the model to capture DR programs.

IOWA AOP MODEL PROGRAM BUNDLES

The following tables present how the Iowa AOP Study program bundles were defined. Further details on how these programs were characterized and the mapping of current utility programs onto the Iowa AOP Model program bundles is presented in Appendix G: DSM Program Characterization Details.

Table 21: Low Income EE Program Bundles Applied in the Iowa AOP Model[14]

Program	Description
Low-income Single Family Retrofit	Stream for income-eligible residential customers in buildings with up to x units. Typically, programs involve an energy audit with recommended actions and efficiency measures are provided at no cost to the customer (up to a cap).
Low-Income Multi-Family Retrofit	Stream for income-eligible residential customers in buildings with x or more units. Typically, programs involve an energy assessment with recommended actions and efficiency measures for common areas and units that are provided at no cost to the building owner and/or customers (up to a cap).

Table 22: Residential EE and DR Program Bundles Applied in the Iowa AOP Model

Program	Description
Residential New Construction	Programs that provide training, incentives, and technical assistance to builders and other allied professions to increase the market penetration of high performance homes and technologies. The target market includes all new single-family and multifamily homes.
Residential NC Code Compliance	Programs that provide training, incentives, and technical assistance to builders and other allied professions to comply with the requirements of the Iowa Energy Code.
Residential Home Energy Retrofit	Programs that provide incentives for property owners or tenants in single family residential buildings. Typically, these programs include an energy audit with recommended actions as well as direct-install measures and prescriptive incentives (in program or based on eligibility in another program) for a variety of envelope measures and technologies. In some cases, financing is also available.
Residential Multi-Family Retrofit	Programs that provide incentives for property owners, property managers, and landlords of market rate multifamily properties. Typically, the programs will include an energy assessment with recommendations as well as direct-install measures within

[14] The Low-Income New Construction Program was removed from the model because it was determined that there is no SF construction built specifically for the LI sector, and that all MF units (market rate or LI) are captured in the MF New Construction Program.

Program	Description
	tenant units and common areas as well as prescriptive and/or custom rebates. In some cases, financing is also available.
Residential Appliances & Products	Programs that increase awareness and market penetration and provide incentives to encourage residential customers to purchase the most efficiency appliances and electronic products available, and in some cases, to recycle certain older appliances. Incentives may be delivered upstream or as rebates.
Residential HVAC	Programs that increase awareness and market penetration and provide incentives to encourage residential customers to buy the most efficiency heating, ventilation and air conditioning (HVAC) and heat pump water heating technologies available when replacing old equipment or when considering purchases for new construction. In some cases, financing is also available.
Residential Lighting	Programs that increase awareness/acceptance and market penetration and provide incentives to encourage residential customers to purchase the most efficiency lighting (bulbs/fixtures, and controls) technology available. Incentives may be delivered upstream at the manufacturer or retail level or as mail-in rebates.
Residential Tree Planting	As per state legislation, Iowa utilities are required to fund tree planting programs in their service territories. This program will inform the Chapter 35 requirement for an assessment of annual potential for tree-planting programs. *(Chapter 35 Special Program)*
Residential Load Management	Programs that provide financial incentives to residential customers in exchange for allowing the utility to control their HVAC and/or water heater during the summer season. When the company is forecasting the possibility of a system peak demand or when operational conditions require, the utility will cycle off the participating units to reduce peak demand.
Residential Behavioral	Programs that are designed to encourage energy savings through behavioral modification. They typically consist of providing home energy reports, coupled with normative messaging that compares the targeted to households in its cohort. This comparative analysis encourages customers to act to reduce their energy usage.

Table 23: Non-Residential EE and DR Program Bundles Applied in the Iowa AOP Model

Program	Description
C&I New Construction	Programs that provide tailored services and incentives to developers and owners of new C&I buildings or those undergoing major renovations/additions. These programs may also include support and incentives to encourage customers who are purchasing equipment - new or replacement - to choose the most energy-efficient options.
C&I Large Business Retrofits	Programs that provide a range of equipment incentives and technical services to encourage building owners to replace functioning but outdated and inefficient equipment. Projects (and incentives) may be prescriptive and/or custom depending on the program and customer. These programs may also provide ongoing services, including training, retro-commissioning, etc.
C&I Small Business Direct Install	Specialized retrofit programs to help small business customers overcome their unique barriers. These programs may provide energy audits, direct or turnkey installation of measures, and incentives and/or financing.
C&I Tree Planting	As per state legislation, Iowa utilities are required to fund tree planting programs in their service territories. This program will inform the Chapter 35 requirement for an assessment of annual potential for tree-planting programs. *(Chapter 35 Special Program)*
C&I Load Management	Programs that are designed to provide non-residential customers with financial incentives to reduce demand during system curtailment events. During these events, the utilities work the customers to enact various strategies such as load shedding or load shifting. Customers receive information and support from the utilities to ensure program compliance.

DEFINING BEST IN CLASS PROGRAMS

Dunsky performed a jurisdictional scan of some of the best practice utility programs across the U.S. to help ensure that the achievable potential reflects what would be possible by applying the best program models available. In all, we scanned 42 programs from five utilities, reviewing key program design factors such as the marketing budgets and approaches, incentive levels, resulting impact and net-to-gross results (where available). The results supported adjustments to the program characterization settings within the Iowa AOP Model applied under the BAU+ and MAX program scenarios. See Appendix G: DSM Program Characterization Details for a list of the reviewed programs.

Example Characterization: C&I Large Business Retrofit Bundle (Alliant Energy)

These include C&I retrofit programs that provide a range of equipment incentives and technical services to encourage building owners to replace functioning but outdated and inefficient equipment. To characterize the program bundle, Dunsky combined the savings, incentives and costs from four programs in the 2018 from the Alliant Energy Efficiency Plan: Agricultural Sector Program, Business Assessments Program, Change-A Light Program and Custom Rebates Program. To calculate the incentive and variable costs for the program bundle, Dunsky took the average values amongst the programs. For the fixed costs, Dunsky took the aggregate fixed costs of the four programs. To characterize the BAU+ and MAX scenarios, Dunsky then applied the adders for the costs, incentives, and barriers applying the jurisdictional scan results from best-in-class programs and professional judgement.

Using the methodologies and data defined in this section, Dunsky characterized the program bundles in Iowa. A uniform methodology was applied across program types and for each utility, with final adjustments made based on professional judgement.

ACHIEVABLE NET-SAVINGS POTENTIAL

NTGR were applied on a measure-program combination basis at to determine the Achievable Potential within the Iowa AOP Model. For Technical and Economic Potentials NTGR were not applied to the savings. The NTGR were for each measure were set to the highest assessed NTGR from our study, assuming that all programs can be adjusted to meet the highest observed NTGR for a given measure. The same NTGR were used under all Achievable Potential scenarios, but the model can be adjusted to provide gross achievable savings potential by utility and program.

The weighted average NTGR ratio (weighted by program volume) for each utility fell in the 0.70-0.75 range, based on the results presented in Table 24 below, depending on the utility. Conversely, the utilities currently assume an NTGR of 1.0 for all programs. Thus, adjustments are made to compare the utility reported program savings totals and costs per unit savings to the Iowa AOP Model Achievable Potential results.

DSM PROGRAM NET-TO-GROSS RATIOS

In parallel to the Iowa AOP Study we conducted NTGR research to establish free-ridership and spillover rates for various measure types under existing efficiency program for each utility.[15] Five high-volume programs were selected for primary research into NTGR, while the rest were assessed based on finding in secondary sources.

Table 24: NTGR Study Results

Research Strategy	Program Type	Recommended NTGRs		
		Alliant	Black Hills	MidAmerican
Primary Research	Residential Prescriptive (Electric)	0.45	n/a	0.53
	Residential Prescriptive (Gas)	0.46	0.47	0.43
	Nonresidential Prescriptive (Lighting)	0.59	n/a	0.69
	Nonresidential Prescriptive (Non-Lighting)	0.61	0.45	0.48
	Nonresidential Custom	0.52	0.44	0.59
Secondary Research	Residential Appliance Recycling	0.55 (Refrigerators, freezers, and window ACs) 1.00 (Leave-behind CFLs)		
	Residential Assessment	0.76 to 1.00 (Varies by measure type)		
	Residential New Construction	0.80		
	Upstream Lighting	0.42 (CFLs) 0.40 (LEDs)		
	Nonresidential New Construction	0.75		
	Commercial Energy Solutions	0.92 (Direct install measures), 0.78 (RCx)		
	Industrial Partners	0.83		
Deemed Values	Low Income Programs (various), Multifamily, Residential HVAC Tune-up, Business Assessments, Agriculture, Nonresidential Evaluation, Nonresidential Low Income	1.00		
NTGR Not Applicable	Residential Direct Load Control, Residential Behavior, Nonresidential Interruptible, Nonresidential Load Management	n/a		

[15] Iowa Gas and Electricity Potential Study, Net-to-Gross Research, Final Report, Opinion Dynamics Corporation, 2017

3.4 DEMAND RESPONSE PROGRAMS

Two demand response programs are included in the model, one for residential customers and one for non-residential customers. In each case we developed these programs based on the currently offered programs from Alliant and MidAmerican. Moreover, the impact of existing enrollment was included in the model results as it was removed from the base sales forecast along with the other efficiency programs. For these programs, while the kW of enrolled DR capacity may be well defined, the annual kWh of savings from the programs is highly variable.

NON-RESIDENTIAL INTERRUPTIBLE DEMAND RESPONSE PROGRAM

The Interruptible DR program was characterized based on results for the existing utility DR programs presented in the 2015 and 2016 annual reports, where each present a stand-alone non-residential DR program.[16] Each program is based on voluntary enrollment, with the customer curtailing demand when called on by the utility.

The base program participation numbers are taken from the reported achieved curtailment in 2016, this accounts just for enrolled customer who actually participate in curtailment events (rather than total enrollment). We set the potential market size as 150% of the current curtailment capacity, with a base impact set at 100%. The model then assessed the ability of the program to ramp up participation based on customer economics. This represents a maximum possible expansion in the program saturation from 20% to 30%.

The program was applied primarily to the largest consuming customers in the Health/Hospital, Agricultural, Process Industrial and Discrete Industrial segments, thereby excluding customer segments who are unlikely to participate (e.g. Offices, Restaurants and Grocery etc.). The increased enrollment in each segment was estimated based on current reported capacity curtailment result.

Key Assumptions:

Demand Savings: 1kW – the program is defined on a per kW of demand curtailment capacity enrolled

Energy Savings: 1.89 kWh - energy savings are estimated from reported results in 2015-16

Incentive Levels: Incentive levels were established based on the average utility reported customer cost per kW enrolled ($45.81) and the average reported utility payments or incentives per kW enrolled.

EUL: 1 year – assuming that enrollment in the program must be renewed annually.

Barrier Levels: Moderate for all customers, and the program was assumed to have no impact to reduce barrier levels to participation as there is no non-program base case uptake to consider.

RESIDENTIAL DIRECT LOAD CONTROL/DEMAND RESPONSE

The Residential Direct Load Control (DLC) program provides incentives to residential customers who agree to have their central air conditioning or heat pump system remotely cycled off during peak periods. In addition to

[16] The Alliant Non-Residential Interruptible Program and MidAmerican's Non-Residential Curtailment Program.

air conditioner and heat pump, participants can also allow the utilities to control their electric hot water heater for increased incentives and peak savings.

The Direct Load Control measure characterization is based on assumptions presented in Alliant's 2016 Energy Efficiency Report[17].

Key Assumptions:

Average Peak Demand Savings per participant: 1kW

Annual Incentive to participants: $30

Estimated Useful Life: 1 year. Although the paging equipment has a longer measure life, since incentives are provided annually and customers can opt-out of the program at any time, a one-year measure life is used. The controller equipment costs and installation costs are not included in the analysis since the equipment remain the property of the utilities for the duration of a customer's participation.

Applicable Population: Customers with central air conditioning or heat pump

Barrier Levels: Assumed to be extreme, considering historical enrollment to Residential Direct Load Control program by utilities

Program Uptake: Participation to the program is derived from the utilities 2018 Forecast[18,19]. A net annual increase of 1% y/y is assumed for year 2 to 10.

---

17 Interstate Power and Light, Annual Report for 2016 Energy Efficiency Plan, Appendix D Benefit Cost Model Demand Response (DR).xls

18 Interstate Power and Light, 2014-2018 Energy Efficiency Plan

19 MidAmerican Energy Company, 2014 – 2018 Energy Efficiency Plan

3.5 SPECIAL PROGRAMS (AS PER CHAPTER 35 RULES)

Chapter 35 requires that three "special programs" be included with the Iowa AOP Study. These programs are defined as:

- Peak demand and energy savings from programs targeted at qualified low-income customers, including cooperative programs with community action agencies
- Implementation of tree-planting programs; and
- Peak demand and energy savings from cost-effective assistance to homebuilders and homebuyers in meeting the requirements of the Iowa model energy code.[20]

In response to this requirement, we included the following three programs and the corresponding measures to capture the potential savings from these special program definitions.

LOW-INCOME PROGRAMS

The Iowa utilities provide various programs that target low-income qualified customers. The Iowa AOP Model characterizes these programs as within two bundles: The Low-Income Single Family Retrofit and the Low-Income Multifamily Retrofit programs. As per Chapter 35 requirements, programs targeted at low-income customers are characterized differently than non-special programs in two ways.

First, the low-income programs are not screened for cost-effectiveness, which allows additional measures to be included in the programs. However, for some larger measures (such as Ground Source Heat Pumps) cost-effectiveness screening was included based on them not being commonly included in low-income programs. A list of the measures screened and not screened are in Appendix H of Volume 2 of this report.

Second, all low-income programs have their incentive levels set at 100% as per best in class examples of low income programs.

TREE PLANTING (CHAPTER 35)

Iowa utilities are required to fund tree planting programs in their jurisdictions. The utilities partner with non-profits, educational institutions, and governmental stakeholders to manage the plantings. Trees are planted in existing buildings and in new construction projects, including the multi-family, single family, low-income, schools, and government buildings market segments.

This program will inform the Chapter 35 requirement for an assessment of annual potential for tree-planting programs. While the characterization for all other measures are reported in the general methodology section of this report, due to the unique nature of tree planting, The Dunsky Team decided to detail the process separately. Following is a summary of the methodology, assumptions and energy savings results of the characterization.

[20] Article 35.8(1), item d. in Chapter 35 legislation

Through interviews with the Iowa Trees Forever program, and a secondary literature review, the Dunsky Team characterized the energy savings and costs for a tree measure for the residential and non-residential sectors. Due to the diversity of trees being planted, we made certain assumptions regarding the tree size, mature height, age to maturity, species and distance and direction planted from the building for which it provides savings. Using these assumptions, we calculated that in an electric heated building, an average tree saves 63.83 kWh of electricity in its growth stage, and 638.3 kWh per year once it has reached maturity. For gas heated buildings, an average tree saves .182 Dth per year of gas during its growth stage and 1.82 Dth of gas during its mature stage. Other critical inputs, such as demand savings, market sizes, and costs are detailed in the memo, included in Appendix: Section I.

RESIDENTIAL NEW CONSTRUCTION CODE COMPLIANCE

This program bundle refers to programs that provide training, incentives, and technical assistance to builders and other allied professions to comply with the requirements of the Iowa State Energy Code in all new single-family homes. Overall the programs are assumed to combine an incentive covering portion of the cost of performing a HERS rating on a new home and marketing to builders and home owners to transform the market such that this becomes the expected code compliance pathway for new home buyers. Training for builders may also include other initiatives such as applying improve code compliance checklists.

To characterize the Residential New Construction Code Compliance measure, upon which this program is based, we reviewed relevant industry reports, and conducted interviews with market actors[21] to verify our code compliance program and measure assumptions.[22] More details of these interviews are in the Appendix: Section H.

Upon review of a 2011 report by the Iowa Department of Public Safety[23], and through communication with a representative at the Department, it was found that 75% of new homes apply a prescriptive path to Iowa State Energy Code compliance, rather than the performance path (a HERS-rating including blower-door test), and that the vast majority of these homes are likely non-compliant to some degree. Non-compliant elements can have an important impact on energy use, such as lighting, air/duct sealing, wall/basement insulation and HVAC equipment sizing and efficiency.

A recent study by the Midwest Energy Efficiency Alliance estimated that there was a 4.5% potential energy saving opportunity in homes that were non-compliant with the State Energy Code in Kentucky.

Based on these findings, we apply the following assumptions in Code Compliance Measure and Program:

---

[21] Including: Iowa department of Public Safety, The MidWest Energy Efficiency Alliance, Iowa Code Inspectors and Iowa-based builders (See Appendix H: Code Compliance Interview Findings for further details).

[22] It is noted that no direct measure of residential new construction code compliance was conducted as part of this study.

[23] Iowa Department of Public Safety, Division of State Fire Marshal, State Building Code Bureau, "Iowa Energy Code Evaluation Pilot Study, Final Report," June 2011

- Measure costs (to homeowner): Cost of conducting a HERS rating on the home[24]. It is assumed that the builder would pass this cost along to the homeowner.[25]
- Incentive level: 75% of incremental cost (HERS rating)
- Applicable Population: 70% of newly constructed SF homes
- Savings per home: 5% of average heating and cooling load
- Administration Costs: Training and Support for Builders and Code Inspectors, as per Alliant's Builder Training program, prorated by utility customer base, and assuming 1/3 of the program costs are directed at residential builders.
- Barrier level: assumed to be high initially[26] then dropping to moderate as the Iowa State Energy Code becomes better understood and respected.
- Program Barrier level reductions: a successful program is assumed to have an immediate impact encouraging more homes to take the performance path to code compliance, improving inspector.

[24] The cost of performing a HERS-rating is assumed to be $450 based on national average HERS rating cost (source: http://www.resnet.us/energy-rating-faqs, accessed July 10, 2017)

[25] Incremental costs of insulation are not included, and are assumed to be absorbed by the builder in meeting the code requirements.

[26] The high barrier level represents potential resistance from home builders who may prefer the ease of the prescriptive path, potential limitation in code inspectors and HERS raters in the state and a lack of knowledge among new home buyers of the value of HERS ratings. This barrier level may drop significantly for the second period in an effectively marketed program.

3.6 EFFICIENCY FINANCING PROGRAMS

In order to incorporate EE financing programs into the Dunsky Potential Model, we first determined how financing programs may contribute to various components of the Potential Assessment, and which financing program features may have quantifiable impacts on measure adoption.

Utility EE financing programs *do not* impact measure efficiency or cost-effectiveness, therefore:

- Financing does not impact the **Technical Potential**
- Financing does not impact the **Economic Potential**[27]

Similar to incentives, marketing and educational programs, utility EE financing programs *do* reduce barriers and improve the financial case for customers to install efficiency measures:

- Financing contributes to the **Achievable Potential**.

Based on this understanding, an outline of how financing programs are treated in the Iowa AOP is presented below.

FINANCING PROGRAM IMPACTS ON MEASURE UPTAKE IN THE DUNSKY MODEL

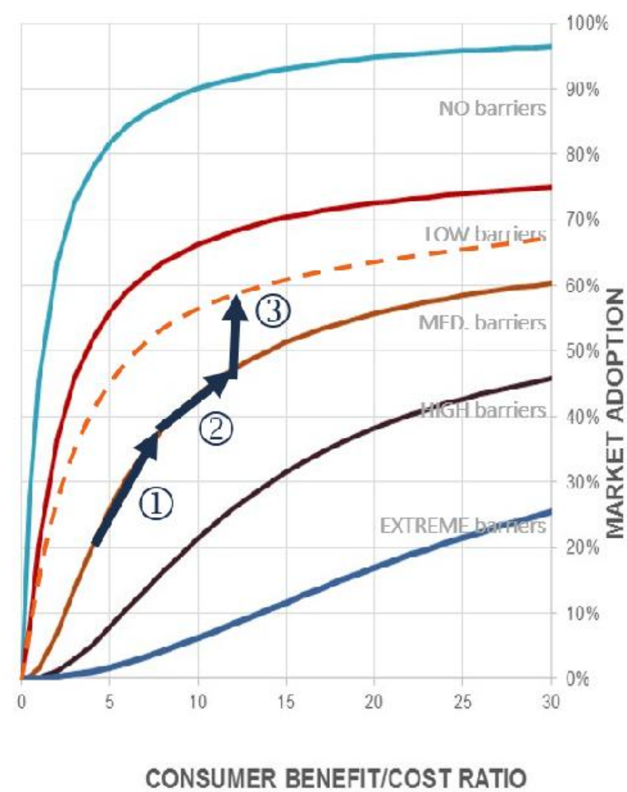
The Dunsky model breaks EE financing down into three features that have varying expected impacts on customer decision-making and measure adoption.

① **Reduced Borrowing Cost:** Programs that reduce borrowing costs (e.g., low interest loans) will improve the consumer benefit/cost ratio (BCR) of a given measure. The resulting increase in adoption in the model is expressed by moving along the same barrier-level adoption curve to the new BCR/Market adoption coordinate.

The Dunsky Potential Model applies the Participant Cost Test (PCT) to assess BCR:

PCT = PV(Benefits) / PV(Costs)

② **Remove *Longer-Payback* Penalty:** The Dunsky Potential Model penalizes residential measures with longer payback periods by adjusting the PCT value to simulate



[27] The assessment of economic potential only considers the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them. Therefore, financing program administration costs and reduced borrowing benefits do not impact the economic potential.

the effect of using payback period to drive adoption decision-making. Extended tenor, non-debt and transferable financing may reduce the customer's negative view of longer paybacks and thus the longer-payback penalty is eliminated. Similar to ① above, the resulting increase in adoption in the model is expressed by moving along the same barrier-level adoption curve to the new BCR/Market adoption coordinate. Because the model only applies the longer-payback penalty to the residential sector this financing program benefit only applies to residential programs.

③ **Reduced Barriers and Risks (iDR):** Financing program attributes that reduce barriers in addition to the impacts described above (e.g., increased access, point-of-sale financing etc.), exert a reduction on a given measure implicit discount rate (iDR). The Dunsky Potential Model employs discrete barrier-levels when characterizing measures for each market sector. Each adoption curve in the Dunsky Potential Model has an associated iDR value. The iDR reduction is applied in the model at the measure-level to modify the adoption curve and generate a new adoption for the measure's associated BCR. In contrast to ① and ② above, the resulting increase in adoption in the model is expressed by moving to a newly defined barrier-level adoption curve.

The table below presents the iDR value associated with each of the barrier levels used in the model. For the "no-barriers" level it is assumed that the iDR is equal to the DR, and this represents the most extensive adoption scenario. As the barrier-level increases in the model, so too does the associated iDR.

Table 25: iDR values associated with barrier-level adoption curves in the Dunsky Potential Model*

None	None-Low	Low	Low-Mod.	Moderate	Mod.-High	High
5%	10%	26%	42%	105%	143%	250%

**** iDR values in the table were calculated based on an assumed 5% Discount Rate. Modifying the base discount rate has a non-linear proportional impact on the resulting barrier-level adoption curve iDRs.***

In the Iowa AOP Study, **most measures fall in the None to Moderate barrier-level categories**. Financing programs included in the model exert a 0.25 to 1 barrier level reduction, depending on the program. This represents a iDR reduction of from 4% to 63% depending on the measure-program combination.

No formal studies have been conducted to estimate the potential impact of financing on assessed iDR values. Thus, we adapted the program barrier level reductions through professional judgement based on program features, and through an iterative approach whereby the financing impacts were compared to financing program impact evaluation results in published studies, then adjusted accordingly.

FINANCING PROGRAMS IN THE IOWA AOP MODEL

The Iowa AOP Model includes five archetype financing program bundles based on commonly applied utility program financing offers.

- **Residential Whole Home Program:** This is a program that is designed to offer long-term financing to encourage deep, whole home retrofits. Eligible measures will be defined at the measure level, focusing on insulation, weatherization, HVAC, and doors and windows. It applies a secured loan model, similar to the Maine PowerSaver loan, that is at a somewhat lower rate than a Home Equity Loan. The barrier reduction represents the expected impact associated with the EE-specific nature of the loan, that can be comarketed with the incentives. Given that the loan will be a long-term, secured product the underwriting criteria would be necessarily strict, and thus the barrier reduction level is set at just 0.25.

- **Residential General Measures Program:** This program offers shorter-term financing at low interest rates (or 0%), and is available for all incentivized residential measures.[28] It is modeled based on an interest rate buy down or loan loss reserve offered to third-party lenders. The barrier level reduction represents the benefits of comarketing the loans with the incentives, and potentially lightened underwriting criteria associated with a loan loss reserve that reduces third-party lender risk.
- **Municipal, University, Scholl and Healthcare (MUSH):** This is a financing program designed to address the capital and long-term financing needs of the Municipal, University, Schools and Health sectors. In the Iowa AOP Model all of the health and education market segments are eligible for this program, along with a portion of the office segment.
- **Small Business (SB):** This is a short-term OBF program that is offered alongside small business incentive programs. In the Iowa AOP Model the commercial market segments are eligible for this program based on the portion of small and medium consuming accounts in each sector.
- **Large Commercial and Industrial (LCI):** This is a medium-term OBF program that is offered alongside large business incentive programs. In the Iowa AOP Model the commercial market segments are eligible for this program based on the portion of large consuming accounts in each sector.

FINANCING PROGRAM INPUTS TO AOP MODEL

The Iowa AOP Model characterizes financing programs along the five fields presented inTable 26 below.

Table 26: Financing Program Inputs to Iowa AOP Model

Program	Borrower Interest Rate Reduction	Loan Tenor (years)	Barrier-Level Reduction	Market Factor
Residential Whole Home	2%	15	1.5	30%
Residential General Measures	5%	5	1	25%
MUSH	7%	10	2	75%
Small Business	7%	3	1.5	40%
Large Commercial	7%	5	1	30%

[28] In the residential sector, it is possible that the Whole Home and General Measures programs could have overlapping measures. It will be assumed that the Whole Home Program will take priority over the General Measures Program given its fit to longer-term payback measures.

- **Borrower Interest Rate Reduction (IRR):** The IRR represents the reduction in the cost of capital to the borrower. It is also used to calculate the program cost to the utilities, which is estimated as the PV of the stream of interest payment reductions over the life of the loan. This is deemed to replicate the approximate costs of an interest rate buy-down, or the cost of maintaining a Loan Loss reserve covering a portion of the loans, in an escrow fund at near 0% interest.
- **Loan Tenor:** This is the maximum tenor of loan in each program. Loan tenors are capped at the measure level, either as the measure's applicable financing program maximum tenor or the measure EUL, whichever is shorter.
- **Barrier Level Reduction:** This is the barrier reduction associated to the financing program by offering improved access to capital, and/or addressing other barriers such as risk reduction.
- **Market Coverage:** The market factor represents the portion of customer in the applicable market segment(s) who would be interested/eligible for the financing offer. These were set for each program based on the survey results, a review of financing program process evaluation studied, and professional judgement.

ASSESSING FINANCING IMPACTS IN THE AOP MODEL

The impacts for each financing feature outlined above are considered to have an additive impact on program adoption in the Dunsky Potential Model. For example, the impact of a residential program that offers long-term financing with a reduced interest rate and utility-bill repayment will be considered in the model as follows: it will remove the longer-term payback penalty, *and* increase the customer BCR through the reduced IR, *and* reduce access barriers through simplified underwriting and possible integration with incentive program marketing.

A financing program's **overall impact can be assessed in the model by comparing projected adoption with and without the financing program in place**: *Financing Program Impact = Δ Adoption*

By establishing the set of residential and non-residential programs that best represents the range of financing options offered by Iowa's utilities, a scenario analysis can be performed by toggling on and off various programs, and comparing the resulting achievable potential to the base case.

FINANCING PROGRAM CHARACTERIZATION DATA SOURCES

To assess the financing program achievable potential contributions, the ability for various financing program attributes to lower the iDR for a given market segment were estimated. There is no formal quantitative method established in the industry to predict these reductions in iDR, and as a result our team applied a qualitative approach to assess iDR impacts.

By gathering and comparing results from a range of data sources and using professional judgement to characterize program impacts on each measure, our team assessed the expected iDR impact for financing program type included in the model. This was expressed as the resulting reduction in barrier levels attributable to various financing program features such as long-term lending and increased access to financing. More details on the financing programs and data reviewed to characterize the financing programs in the Iowa AOP Model is presented in Appendix G: DSM Program Characterization Details.

3.7 UTILITY SALES FORCASTS 2018-2028

We derived the forecast sales for each utility as per the methodology outlined earlier in this report. These forecasts were then used to assess the following metrics:

- **Base Sales Projection:** Since the Iowa AOP Model assesses the achievable potential based on net-savings, the Base Sales Projection is derived excluding the impacts of DSM programs, but including the impact of natural uptake of efficiency measures. In all cases, unless otherwise stated, the base sales refer to projected 2027 base sales**.**
- **Energy and demand savings as a percent of sales:** By dividing energy efficiency savings by the adjusted forecasts, we calculated the metric, savings as a percentage of sales. Dunsky calculated this metric by segment, end-use, sector, and as a cumulative total and incrementally by the year. These are detailed in the results section.

BASE SALES PROJECTIONS

Figures 28 to 31 below present the statewide consumption and demand forecasts for gas and electric in the absence of energy efficiency programs, but including the impact of natural adoption.

Figure 28: Statewide Electricity Base Sales Forecast 2018-2027

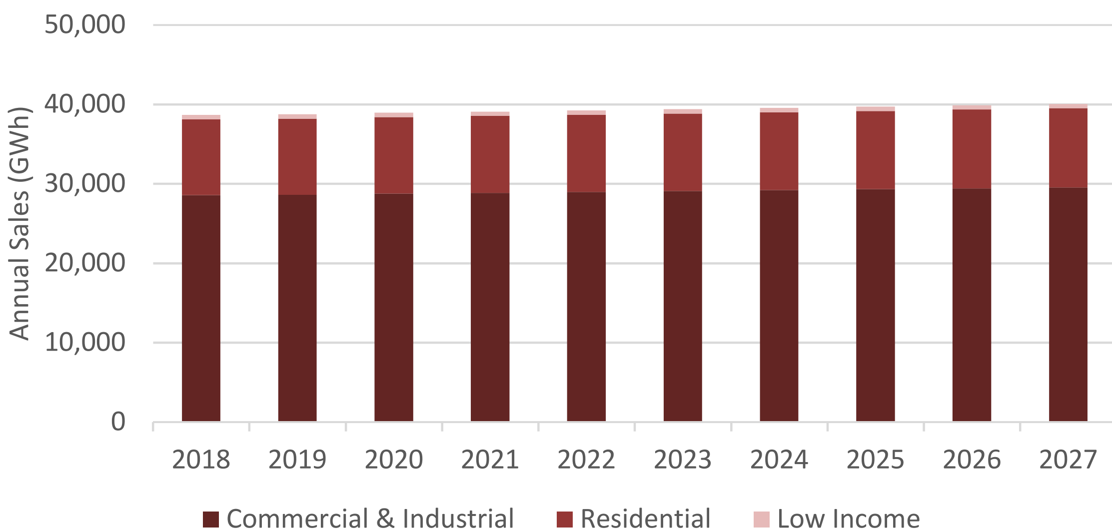


Figure 29: Statewide Electricity Demand Forecast 2018-2027

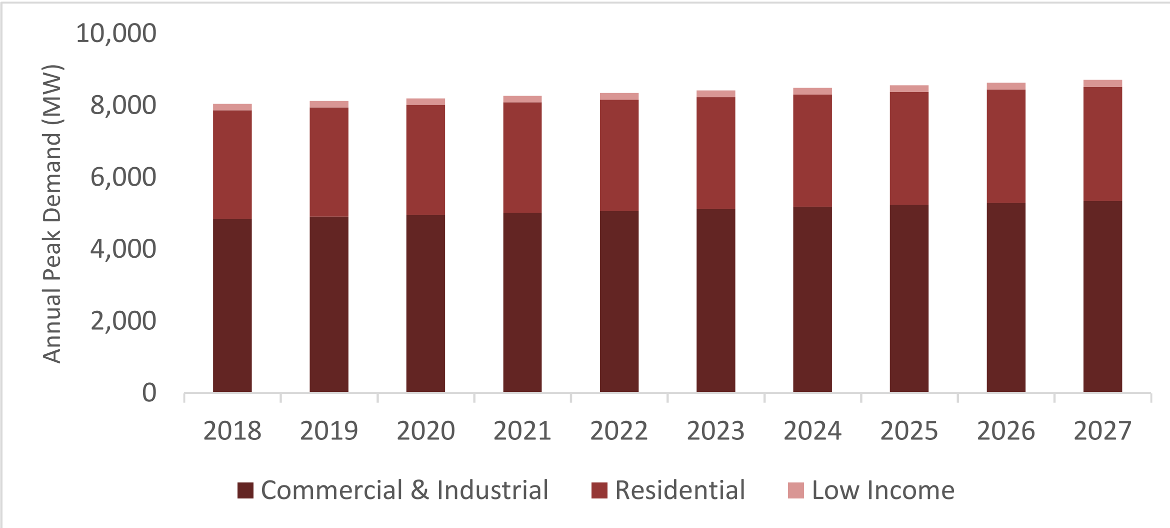


Figure 30: Statewide Gas Base Sales Forecast 2018-2027

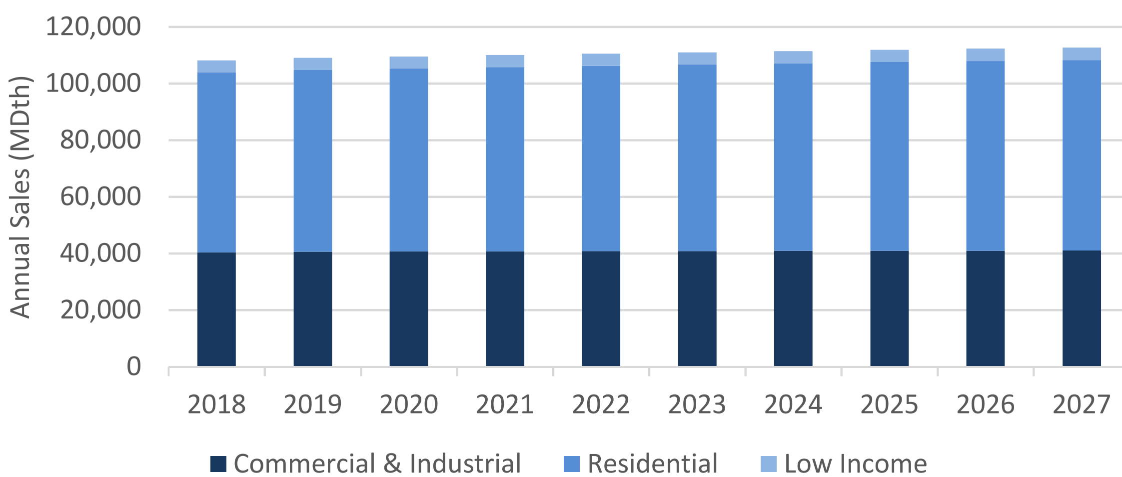
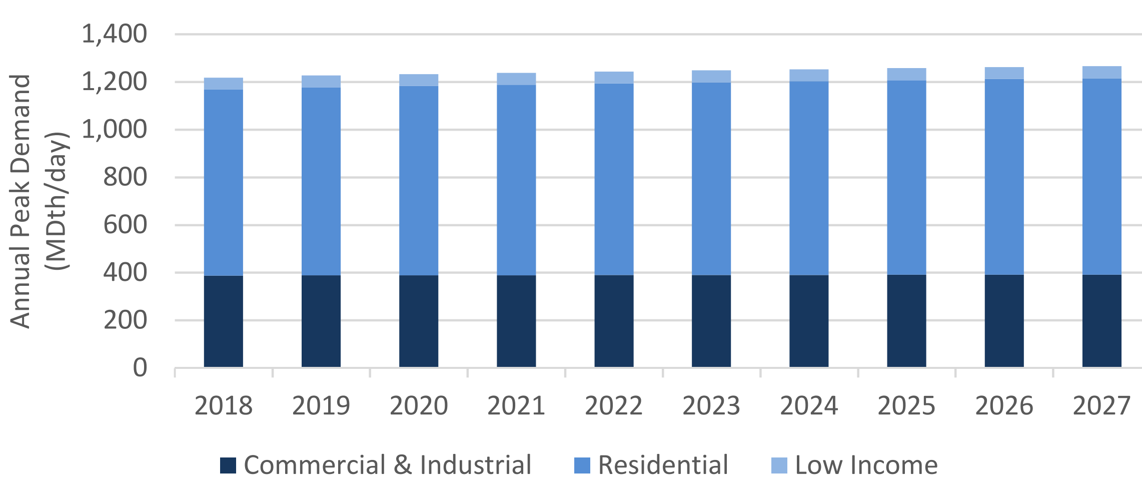


Figure 31: Statewide Gas Demand Forecast 2018-2027



4. ASSESSEMENT OF POTENTIAL: KEY RESULTS

The following graphs and tables present the statewide electric and gas potentials at the technical, economic and achievable levels, covering energy and demand as detailed. The results were assessed for each utilities' portfolio and the contributions were then summed to obtain statewide potentials.

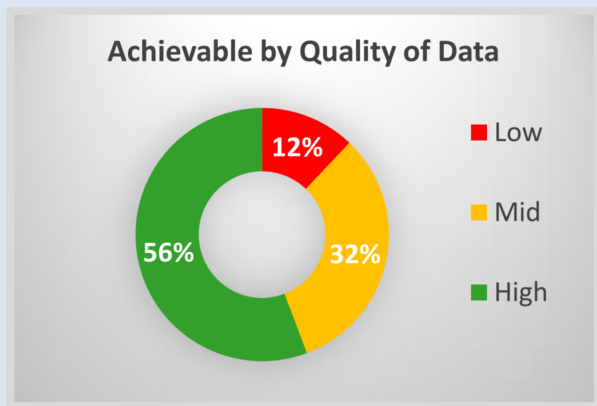
Throughout the following presentation of results and analysis, the reader should be aware of the following:

- Achievable Potential was assessed under the BAU+ case, except where otherwise specified.
- All savings are expressed in at the meter terms, rather than at generation terms- as is the case with the projected sale base case.
- Base sales are expressed as the projected energy and demand in 2027, as specified in the methodology section.
- The Iowa AOP Model accounts for inflation and the time value of money, and as such all benefit and cost assumptions, including program costs, measure costs, avoided energy costs, and marginal rates, are expressed in 2018 dollars.

The majority of the summary and graphs included in the AOP analysis sections are for the statewide potentials. Results for each utility are presented in Appendix K: Assessment of Potential – Results.

Iowa AOP Model Results

Figure 32: Quality of Data by Portion of Savings



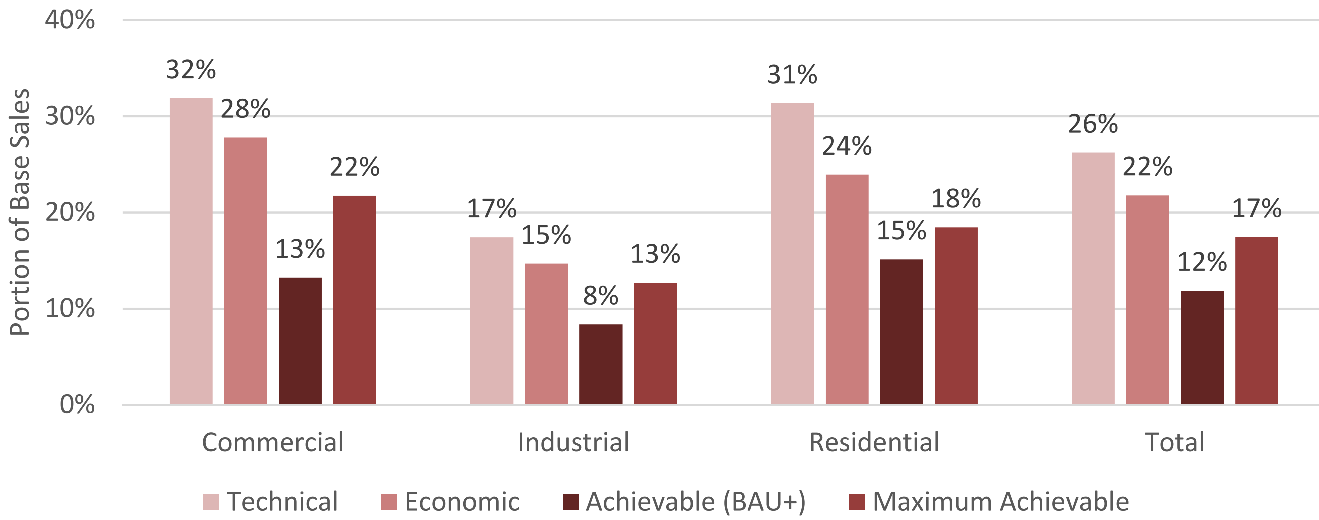
The Iowa AOP Study was based on extensive primary research to assess the market baseline for energy using equipment in Iowa homes and businesses across the three utility service territories. This data was then used as input to the Iowa AOP Model. In assessing the savings potential, the model tracks the portion of savings stemming from measure of varying input data quality.

The high data quality savings arise from measures for which market baseline data was available for all segments, covering all or most measure characterization inputs. Medium quality inputs refer to measures where only a portion of segments had sufficient market baseline data. Low data quality data inputs refer to measures where only broad market data was available at the sector level, and default values were used for the majority of measure characterization inputs.

Figure 32 above shows the impact that the baseline data had on the quality of overall savings assessment from the three utility model results, showing that 88% of the savings stem from measures for which we applied Iowa specific and segment market data.

4.1 STATEWIDE ELECTRIC POTENTIAL

Figure 33: 10-Year Statewide Electric Potentials as Portion of Total Sales by Sector



The statewide electric potentials are presented in Figure 33 above and Table 27 to 29 below. From these results, the following observations can be made:

- **There is significant opportunity across the residential and non-residential markets:** The residential sector represents the greatest achievable potential terms of the portion of base sales, however the commercial sector offers the largest opportunity in terms of absolute GWh of savings. While cumulative residential savings may be large, achieving savings in this market requires successfully accessing a myriad of small savings opportunities (e.g. lighting and small HVAC equipment in homes and apartments.)
- **Industrial sector potential is limited:** The industrial sector offers the lowest electric achievable potential in terms of the portion of base sales. However, its overall GWh of potential savings is larger than that for residential. Given this sector's high electric consumption per customer and the predominance of specialized process equipment, electric savings may be more easily accessed through larger initiatives customized to specific customer needs.
- **Customer economics and market barriers likely limit the non-residential market achievable potentials:** A very high portion of savings opportunities in the commercial and industrial sectors are cost-effective, where economic potentials represent 87% and 84% of the technical potential respectively. But the achievable potentials suffer, likely due to unfavorable economics at the participant level (i.e. lower PCT scores for measures in the non-residential sector due to lower energy prices).
- **Favorable customer economic support achievable potential in the residential sector:** In the residential sector, only 70% of identified technical savings opportunities are deemed cost-effective at the societal level, but the sector achievable potential remains high, likely due to favorable economics (i.e. reasonably short simple paybacks) at the customer/participant level.
- **Maximum achievable potentials approach economic potentials in general:** Maximum achievable potentials were assessed by setting incentive to 100% of measure incremental cost. Overall, this has

the largest impact in the commercial sector, increasing customer economics and measure uptake significantly.

- **Industrial sector offers the highest potential demand savings:** While the residential and commercial sector electric demand achievable potentials are largely in line with their energy potentials, the industrial sector offers significantly higher demand savings, both in absolute terms (MW) and as a portion of base sales demand. This is attributed to high projected industrial customer participation in the Interruptible Demand Response programs.

Table 27: 10-Year Statewide Electric Potentials by Sector (Energy)

	Technical Potential		Economic Potential		Achievable Potential		Maximum Achievable	
	GWh	Portion of Base Sales	GWh	Portion of Base Sales	GWh	Portion of Base Sales	GWh	Portion of Base Sales
Commercial	4,540	32%	3,959	28%	1,881	13%	3,210	22%
Industrial	2,648	17%	2,230	15%	1,269	8.3%	1,931	13%
Residential	3,282	31%	2,505	24%	1,584	15%	1,857	18%
Total	**10,470**	**26%**	**8,693**	**22%**	**4,735**	**12%**	**6,997**	**17%**

Table 28: 10-Year Statewide Electric Potentials by Utility (Energy)

	Technical Potential		Economic Potential		Achievable Potential		Maximum Achievable	
	GWh	Portion of Base Sales	GWh	Portion of Base Sales	GWh	Portion of Base Sales	GWh	Portion of Base Sales
MidAmerican	6,494	28%	5,423	24%	2,893	13%	4,369	19%
Black Hills	276	NA	158	NA	97	N/A	145	N/A
Alliant	3,701	22%	3,112	18%	1,746	10%	2,483	15%
Total	**10,470**	**26%**	**8,693**	**22%**	**4,735**	**12%**	**6,997**	**17%**

Table 29: 10-Year Statewide Electric Potentials (Demand)

	Technical Potential		Economic Potential		Achievable Potential		Maximum Achievable	
	MW	Portion of Demand	MW	Portion of Demand	MW	Portion of Demand	MW	Portion of Demand
Commercial	557	22%	516	20%	280	11%	453	18%
Industrial	510	19%	481	18%	766	28%	921	34%
Residential	1,359	41%	1,284	38%	563	17%	689	21%
Total	**2,426**	**28%**	**2,281**	**27%**	**1,609**	**19%**	**2,063**	**24%**

PHASE-IN ELECTRIC POTENTIAL

The phase-in potential was assessed, considering the uptake of measures according to equipment replacement and installation schedules, and changing market sizes and customer economics. Overall, from Figures 34 and 35 below, it can be observed that the annual incremental potential is greatest in the initial years of the AOP study period (2018 – 2020), after which the annual incremental potential flattens off for the remaining years. This is due to the impact of the EISA lighting standards taking effect in 2021, whereby the savings attributable to many lighting measures will be reduced or eliminated. It is also likely to be somewhat the effect of low EUL measures being installed early in the study period, and while they may be replaced later, they would not by definition provide additional cumulative savings.

Figure 34: Statewide Electric Phase-In Electric Potentials

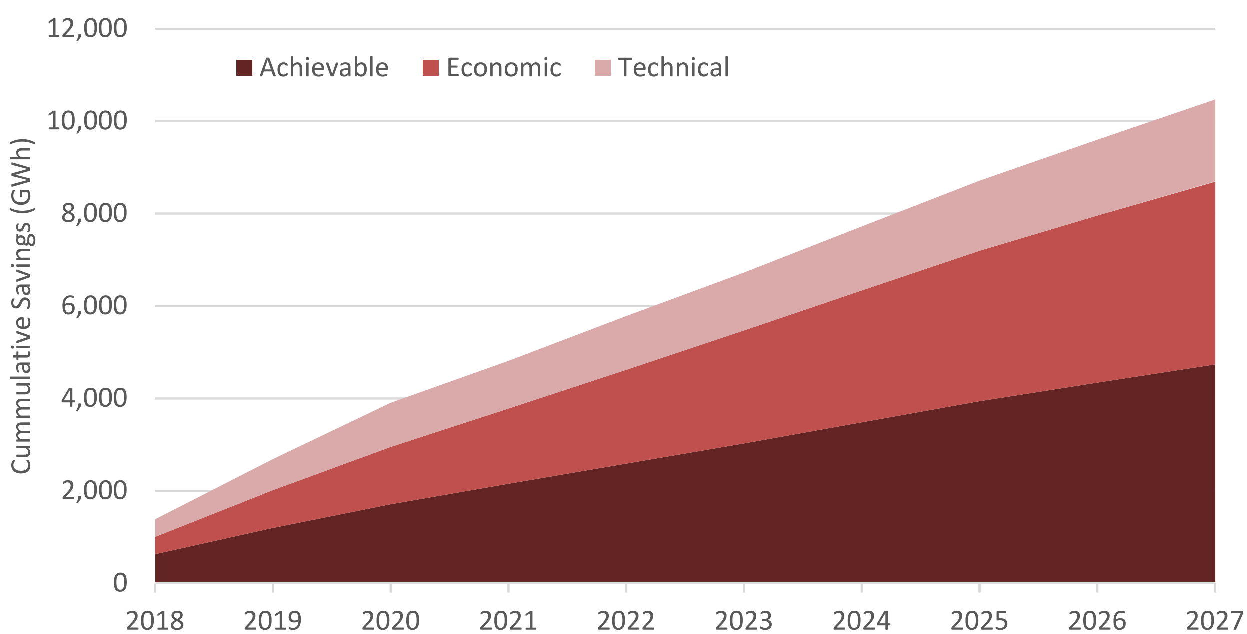
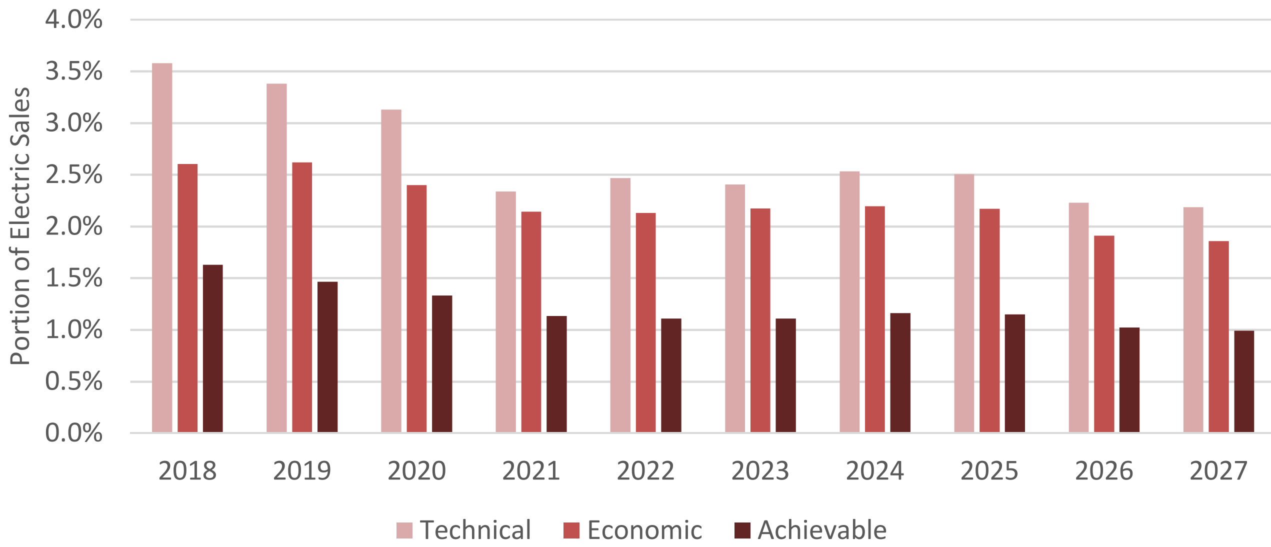
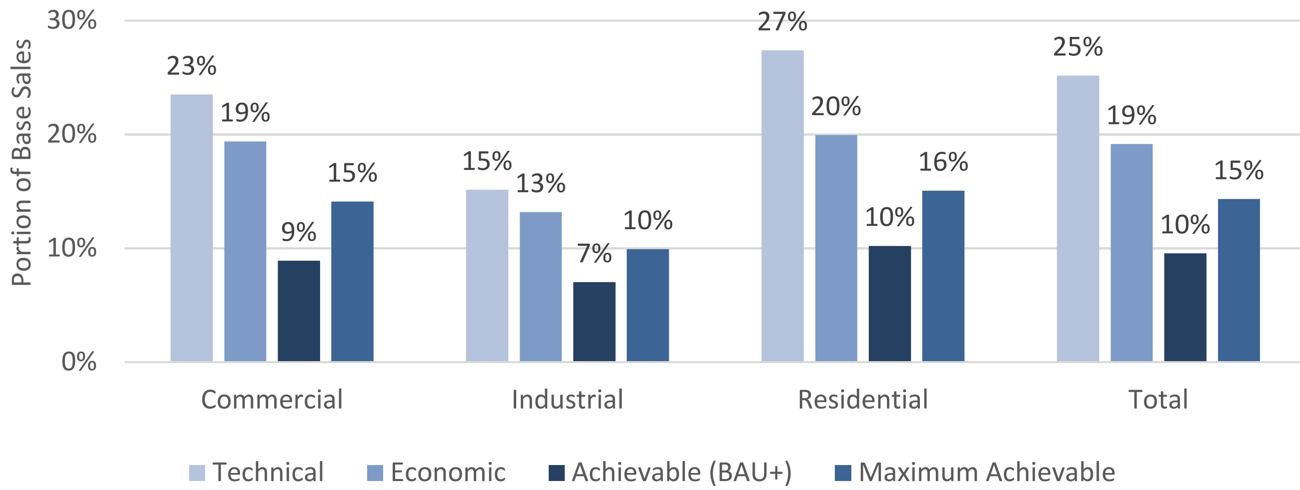


Figure 35: Statewide Annual Electric Potential as Portion of Electricity Sales



4.2 STATEWIDE GAS POTENTIAL

Figure 36: 10-Year Statewide Gas Potentials as Portion of Total Sales by Sector



The statewide gas potentials are presented in Figure 36 above and Table 30 to 32 below. From these results, the following observations can be made:

- **The residential sector represents by far the greatest gas savings potential:** The residential sector demonstrates the greatest achievable potential, compared to the commercial and industrial sectors, both in the portion of base sales and in absolute dekatherms of savings. While these savings may cumulatively be large, given the nature of the residential market, achieving these savings would require successfully accessing a myriad of small savings opportunities, mostly related to home furnaces, water heating and envelope improvements.
- **Industrial sector potential is limited:** The industrial sector offers the lowest gas achievable potential, both as a portion of base sales and in absolute terms.
- **Customer economics and barriers likely limit gas achievable potentials in general:** In all sectors, the economic potential of gas savings represents a high portion of the overall technical potential, averaging over 78% of the overall technical potential. However, the achievable potentials represent a much smaller portion, averaging just 50% of the economic potentials, which suggests that gas savings are limited primarily by customer economics and barriers.
- **Maximum achievable potentials approach economic potentials in general:** Maximum achievable potentials were assessed by setting incentive to 100% of measure incremental cost. Overall, this has the commercial and residential sectors, increasing customer economics such that the maximum achievable almost reaches the economic potential.
- **Residential sector offers the highest potential demand savings:** The residential sector offers the greatest gas demand savings potential both in absolute terms (MDth/day) and as a portion of base sales demand. This is attributed to the overall high portion of gas saving opportunities in the residential sector, and the likelihood that residential gas using equipment often has a high winter peak coincidence factor.

Table 30: 10-Year Statewide Gas Potentials by Sector (Energy)

	Technical Potential		Economic Potential		Achievable Potential		Maximum Achievable	
	MDth	Portion of Base Sales	MDth	Portion of Base Sales	MDth	Portion of Base Sales	MDth	Portion of Base Sales
Commercial	7,107	23%	5,864	19%	2,689	9%	4,451	15%
Industrial	1,614	15%	1,405	13%	748	7.0%	1,104	10%
Residential	19,541	27%	14,224	20%	7,283	10%	11,556	16%
Total	**28,262**	**25%**	**21,493**	**19%**	**10,721**	**10%**	**17,121**	**15%**

Table 31: 10-Year Statewide Gas Potentials by Utility (Energy)

	Technical Potential		Economic Potential		Achievable Potential		Maximum Achievable	
	MDth	Portion of Base Sales	MDth	Portion of Base Sales	MDth	Portion of Base Sales	MDth	Portion of Base Sales
MidAmerican	15,528	24%	13,579	21%	6,361	10%	9,832	15%
Alliant	7,077	25%	4,236	15%	2,488	9%	3,971	14%
Black Hills	5,658	30%	3,678	20%	1,873	10%	3,317	18%
Total	**28,262**	**25%**	**21,493**	**19%**	**10,721**	**10%**	**17,121**	**15%**

Table 32: 10-Year Statewide Gas Potentials (Demand)

	Technical Potential		Economic Potential		Achievable Potential		Maximum Achievable	
	MDth/ day	Portion of Base Sales	MDth/ day	Portion of Base Sales	MDth/ day	Portion of Base Sales	MDth/ day	Portion of Base Sales
Commercial	42	15%	31	11%	13	4.6%	26	9%
Industrial	9	9%	7.6	7.5%	4	3.7%	6	6%
Residential	222	26%	185	21%	90	10%	133	15%
Total	274	22%	224	18%	**107**	**8.4%**	**166**	**13%**

PHASE-IN GAS POTENTIAL

The gas phase-in potential was assessed, considering the uptake of measures according to equipment replacement/ and installation schedules, and changing market sizes and customer economics. Overall, it can be observed from Figure 37 below that after an initial peak in the achievable potential in the first year of the study period, the annual incremental largely potential flattens off for the remaining years with some minor fluctuation. This is likely attributable to the model capturing the effects of a higher portion of lower EUL measures in the early years, and while they may be replaced later, they would not by definition provide additional cumulative savings.

Figure 37: Statewide Phase-In Gas Potentials

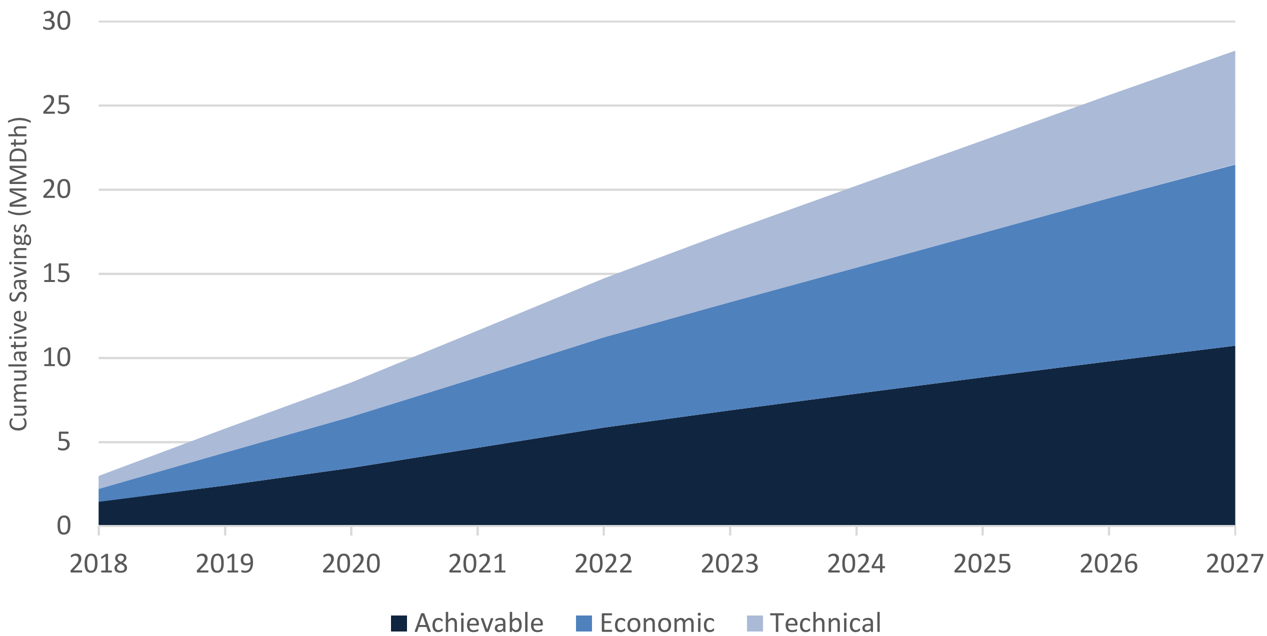
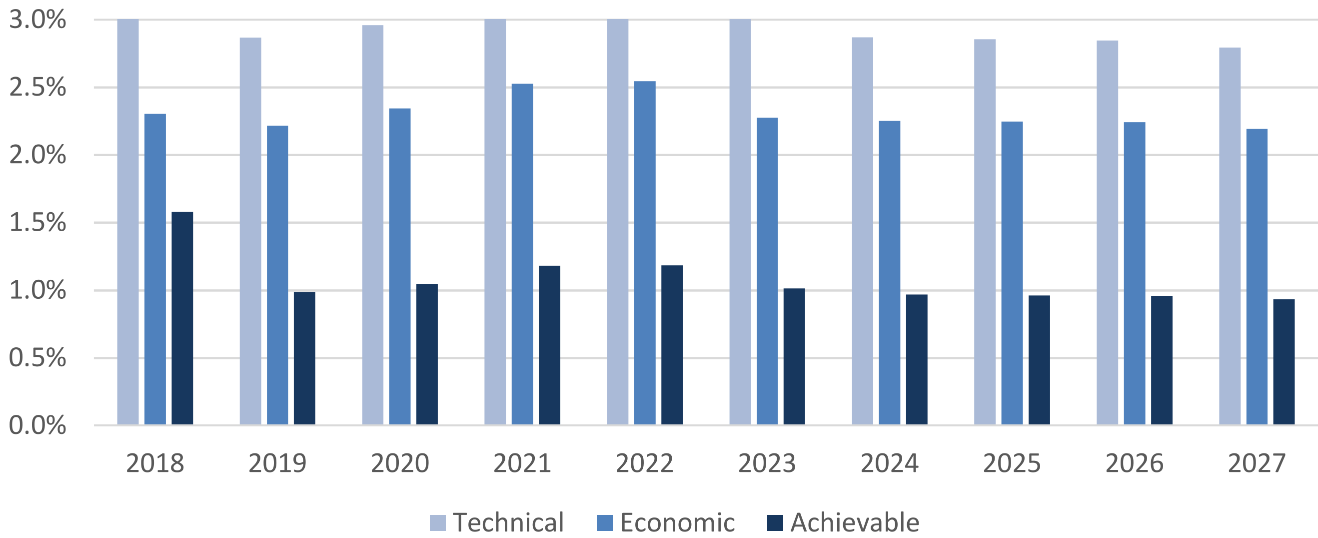


Figure 38: Statewide Annual Potential as Portion of Gas Sales



4.3 ACHIEVABLE, PROGRAM AND GRID LEVEL SAVINGS

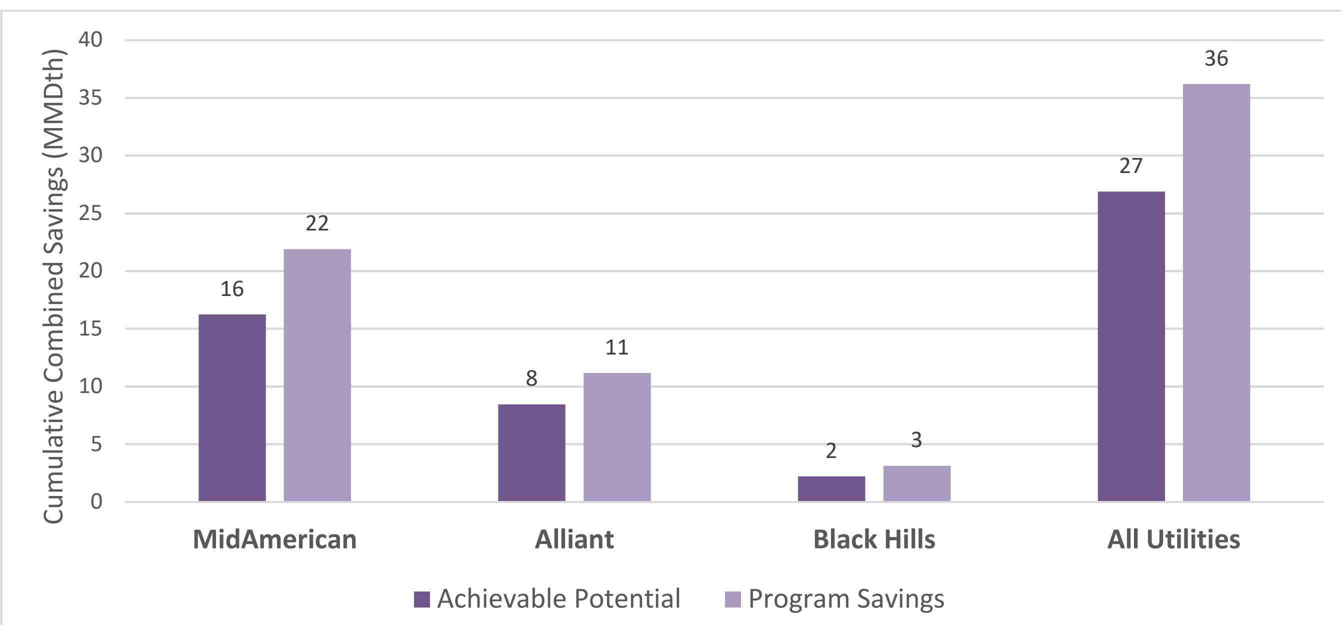
The Iowa AOP Model provides the achievable potential in terms of cumulative savings over the study period attributable to utility programs. However, the cumulative grid-level impacts across each utilities service territory and the reportable savings in DSM programs will be somewhat different than the achievable potential values. The following sections provide an explanation of these differences and present a comparison of cumulative savings among the various perspectives.

PROGRAM SAVINGS VS ACHIEVABLE POTENTIAL

The achievable potential represents the cumulative savings resulting from the efficiency measures and programs. However, for measures that have shorter than ten-year EULs, the same measure may be installed more than once over the study period. In these cases, the second installation would not contribute additional cumulative savings, since the opportunity was already accounted for in the first measure install, and therefore it would be counted a second time toward the achievable potential. Conversely utility DSM program may provide an incentive for both installations, and therefore the savings would be reported as part of the program impacts for each instance. This leads to the following:

- **Program savings are greater than the achievable potential:** A significant portion of measures have EULs shorter than 10-years, and therefore the combined program savings are on average 34% greater than the achievable potential (as shown in Figure 39 below).
- **Cost per unit savings are calculated based on Program Savings in this report:** Calculating the cost per unit energy from program savings allows an apples-to-apples comparison of Iowa AOP Model program costs with current utility DSM program costs per unit savings.

Figure 39: Comparison of 10-Year Cumulative Modelled Program Savings with Achievable Potentials



GRID LEVEL IMPACTS

Because each utility in the Iowa AOP Study has its own customer base and applies its own billing rates, discount rates and avoided costs of energy and demand, it was necessary to construct three separate models to assess the statewide potential. The Iowa AOP Model developed for each utility determines the total electric and gas savings attributable to that utility's programs. However, because some customers may have a different gas and electric service provider (either one of the utilities here, or a local coop), some savings created by each utility's programs may impact a different another utility's sales.

Table 33: Comparison of Achievable Potential to 10-Year Cumulative Grid-Level Impacts

	Achievable Potential		Network Impacts		Difference	
	Electric (GWh)	Gas (MDth)	Electric (GWh)	Gas (MDth)	Electric	Gas
MidAmerican	2,893	6,361	2,838	6,285	-2%	-1%
Alliant	1,746	2,488	1,767	2,454	+1%	-1%
Black Hills	97	1,873	0	1,908	-100%[29]	+2%
Total	**4,735**	**10,721**	**4,606**	**10,647**	**-3%**	**-1%**

The easiest way to understand this effect, is to consider the electric savings generated by Black Hills' gas programs. As Black Hills does not provide electric service, all electric savings generated by its programs impact the sale of another utility.

As a final step in the AOP, we applied corrective factors to redistribute the program savings to the appropriate utilities to assess the grid impacts for each of the utilities.

From Table 33 above the grid level impacts are only marginally different than the achievable potential for each utility, with some slight increases and some slight decreases. Statewide there is a minor loss of potential at the network level as a portion of the savings would impact local utilities that are not included in this study. The contribution that local utility programs may have on the IUA utilities was not included within the scope of this study, so it is not clear if these network level savings losses would be offset by contributions from local utility programs, where they exist.

[29] All electric savings resulting from Black Hills programs will impact other electric utility networks as Black Hills does not provide electric service in Iowa.

4.4 COMPARISON TO 2012 IOWA POTENTIAL STUDY RESULTS

To provide further context to the Iowa AOP Study results, we compared the findings to the past two statewide potential studies conducted in Iowa, in 2008 and 2012.[30]

There are a number of key differences between the approaches applied in the 2012 and 2017 studies that are worth taking note of when considering the results.

- The 2017 Study was based on extensive primary data collection to establish the Market Baseline.
- The 2017 study applied a bottom-up modeling approach to assess the achievable potential and costs of savings, while the 2012 study applied a bottom up model for the Technical and Economic potentials, but a top-down approach for the achievable potential.
- The commercially available measures applied have evolved between 2012 and 2017:
    - The Iowa TRM Volume 1 released in 2016 was the basis of the 2017 measure list and savings characterization, along with some additional measures.
    - The 2012 applied measure list was based on utility program measure lists and other libraries.
    - The EISA lighting standards are expected to impact lighting baseline technology definitions.
    - A number of measures have emerged in the market while others are no longer considered.[31]
- The two studies appear to have arrived at slightly different assessments of the overall statewide energy consumption baseline, particularly regarding gas customers.
- The 2017 study applies assessed NTGR for each measure based on primary and secondary research performed in parallel to the AOP Study, while in previous studies an NTGR of 1.0 was applied.

[30] Source: The Cadmus Group Inc, "Final Report: Assessment of Energy and Capacity Savings Potential in Iowa", February 28, 2012.

[31] A number of measures that are commercially available in the study period were not yet considered viable in the 2012 assessment. Examples include: LED Replacement of Linear Fluorescents, Heat pump water heaters, Energy Recovery Ventilators. In other cases, measures that provided significant potential in 2012 have either been superseded by emerging technologies, or have become (or will become) the baseline technology over the study period.

Figure 40: Comparison of 2008, 2012 and 2017 Iowa Statewide Electric Potential Assessments

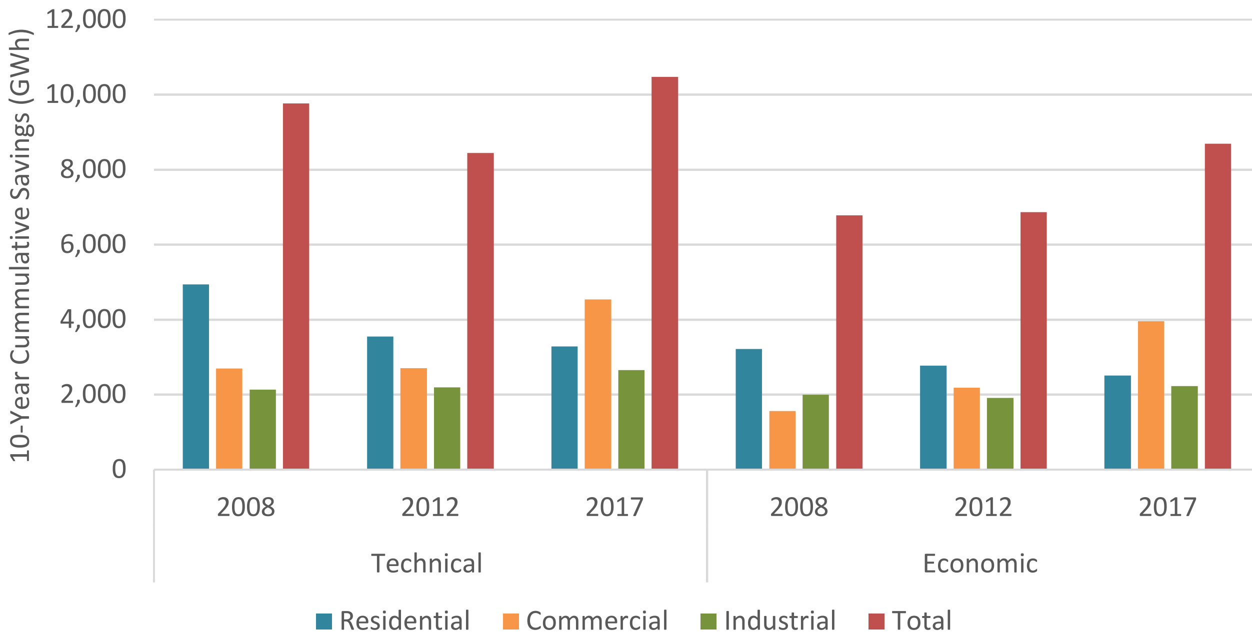
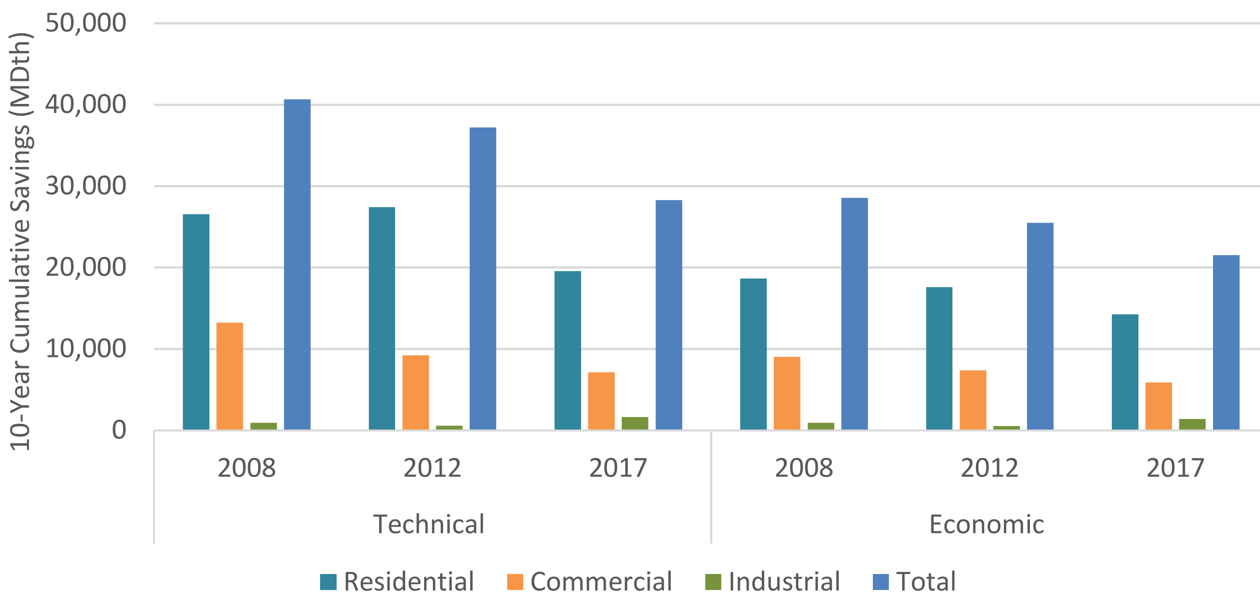


Figure 41: Comparison of 2008, 2012 and 2017 Iowa Statewide Gas Potential Assessments



Figures 40 and 41 above present a comparison of the gas and electric technical and economic potentials in the 2008, 2012 and 2017 potential assessments for Iowa. The comparison shows a general agreement with a few notable trends in the 2017 results:

- **Increased commercial sector potential:** The electric technical and economic potentials are higher for the commercial sector in the 2017 study than in previous studies (2008 and 2012). Given the predominance of lighting measures in that sector, this may be partially a result of the emergence of linear LEDs.

- **Increased overall electric potential:** The overall electric technical and economic potentials are higher in the 2017 study than in previous studies. This could be a result of increased precision on measure costs through TRM, along with the detailed market baseline results that quantify the number of opportunities.
- **Gas potential remains consistent:** Overall the gas potential results are similar among the studies, with the 2017 study indicating somewhat lower overall total potentials, except for the industrial sector.

Table 34 Comparison of Achievable Potential in 2012 and 2017 Assessments

	Achievable Electric Potential		Achievable Gas Potential		Portfolio
	GWh	Portion of Base Sales	MDth	Portion of Base Sales	Budget ($ 2018)
2017 AOP (Net Savings)	4,735	1.19%	10,720	0.95%	$ 397 M
2017 AOP (NTGR = 1)	6,576	1.65%	14,890	1.33%	
2012 AOP (NTGR = 1 applied)	6,284	1.12%	15,661	0.92%	$ 219 M

Table 34 provides a comparison of the achievable potential results between the 2017 and 2012 studies. From those results the following conclusions are drawn:

- **Achievable potential in Iowa has risen as a portion of the base sales, but has somewhat dropped in absolute energy terms.** Both the gas and electric potentials are somewhat lower in the 2017 than in the previous study, but represent higher portions of annual sales, and come at a higher program cost.
- **If gross savings are considered, the achievable potential has risen substantially (over 50% on a portion of sales basis):** Because the 2012 appears to have applied a NTG = 1 for all programs, while the 2017 study applied NTGR based on largely based on primary research conducted on Iowa's utility DSM programs (average NTGR was 0.72 across programs), a comparison of gross savings may be a more appropriate benchmark. In this case we see that the achievable potentials have risen by 52% on the basis of the portion of electric sales, and 60% on the basis of the portion of gas sales.
- **Higher program costs and portion of sales suggest that savings are getting costlier to achieve:** The high program costs and savings percentages together may indicate the past programs have been successful in lowering the overall energy demand in Iowa, and that savings in the coming years will have to access costlier opportunities as standards and baseline technologies evolve, and the lowest handing fruits are exhausted.

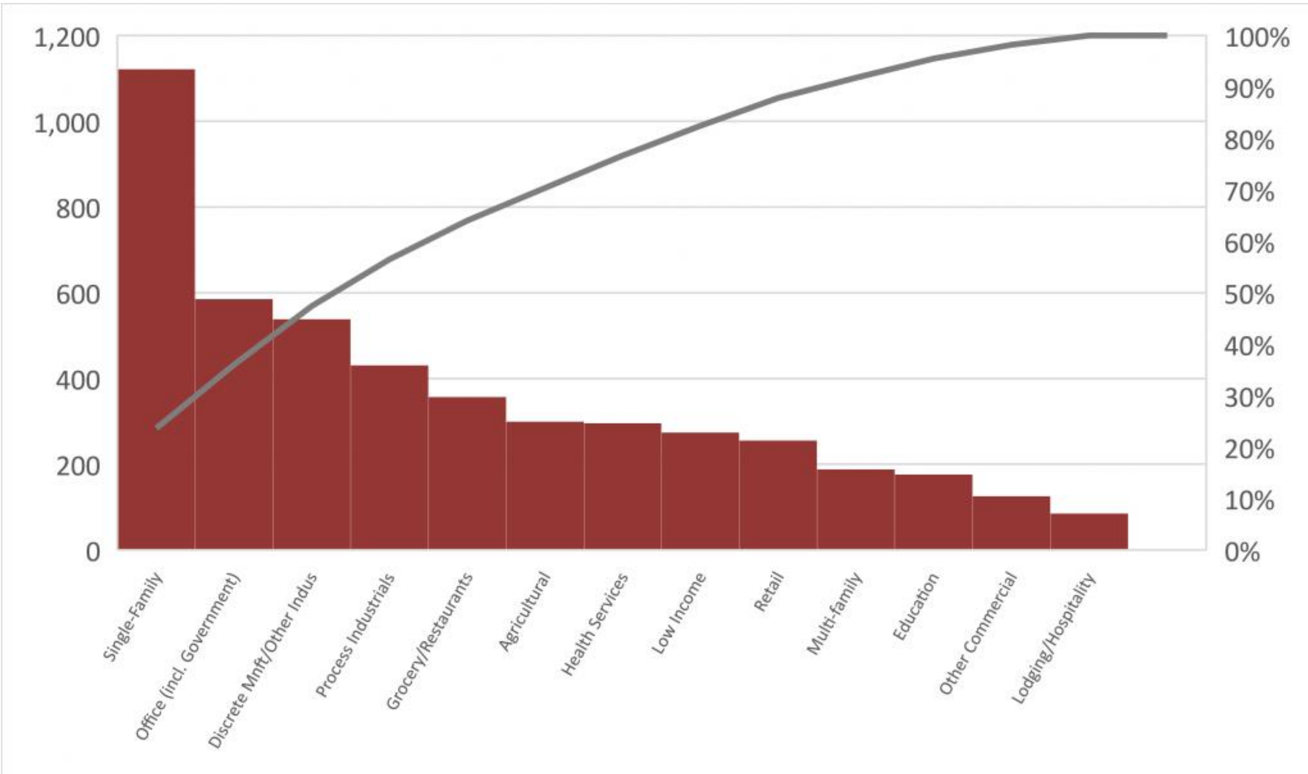
- **Lower gas prices in 2016 may be limiting savings potential and raising program costs:** While the utility projected gas prices remain confidential, a comparison of historical gas prices shows nearly a 20%[32] drop between 2012 and 2017 (on a price per cubic foot delivered to customers basis). Reduced gas prices would weaken customer economics for efficiency, and thereby contribute to a reduced achievable potential. Moreover, lower gas prices would also increase the program incentive levels needed to achieve savings that pass the participant cost test, thereby raising the program costs.
- **The significantly higher program costs in the 2017 study, compared to the 2012 study, are likely the result of a combination of lower gas costs, applying evaluated NTGR and higher achievable potentials as a portion of gas and electric sales.** A range of factors likely contribute to the higher estimated program cost. In addition to the ones listed above, the application of the Iowa TRM may cause the 2017 study to apply higher average incremental costs, although no incremental cost data was available to support the 2012 study to confirm.

[32] Based on gas price information from EIA, adjusted for inflation: https://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SIA_m.htm (Accessed June 2017)

4.5 DETAILED ELECTRICAL ACHIEVABLE RESULTS

A detailed breakdown of the statewide electric achievable potential (under the BAU+ base case) is presented in the following section. The top ten grouped measures for each sector are also presented, as well as the list for the low-income segment. Further detailed results of achievable potential by end use and segment for each utility are provided in Appendix K: Assessment of Potential – Results Tables

Figure 42: 10-Year Electric Savings by Market Segment: All Sectors (GWh)



Overall, the detailed results indicate that:

- **Single-family homes represent the highest segment of electrical potential:** The single-family homes offer a significant LED lighting savings potential (interior and exterior), along with AC and refrigerators and other HVAC and lighting applications.
- **The offices segment offers the next highest savings potential:** The high electric savings in the office stem primarily from lighting (LED Low-Bay and linear fixtures), HVAC measures and other measures such as Retro-commissioning and EMS improvements.
- **The process and discrete manufacturing segments collectively offer significant electric savings:** These segments are dominated by custom savings measures related to the unique nature of the facilities, as well as VFD/VSD drives, refrigeration, and high and low bay lighting opportunities.

While these segments represent the largest opportunities, Figure 42 above indicates that significant electric potential is distributed across most sectors and segments.

Figure 43: 10-Year Total Electric Savings by End-Use (Values in GWh)

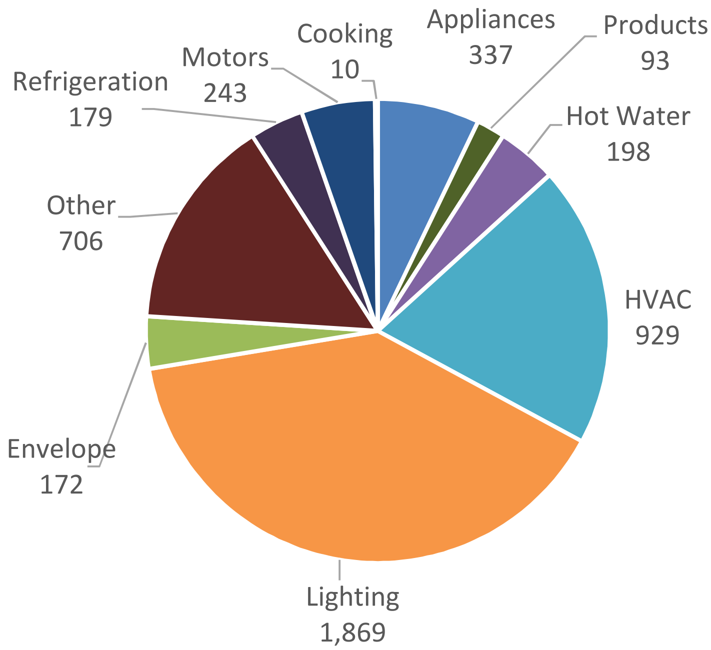


Figure 44: 10-Year Residential Sector Electric Savings by Market Segment and End-Use (Values in GWh)

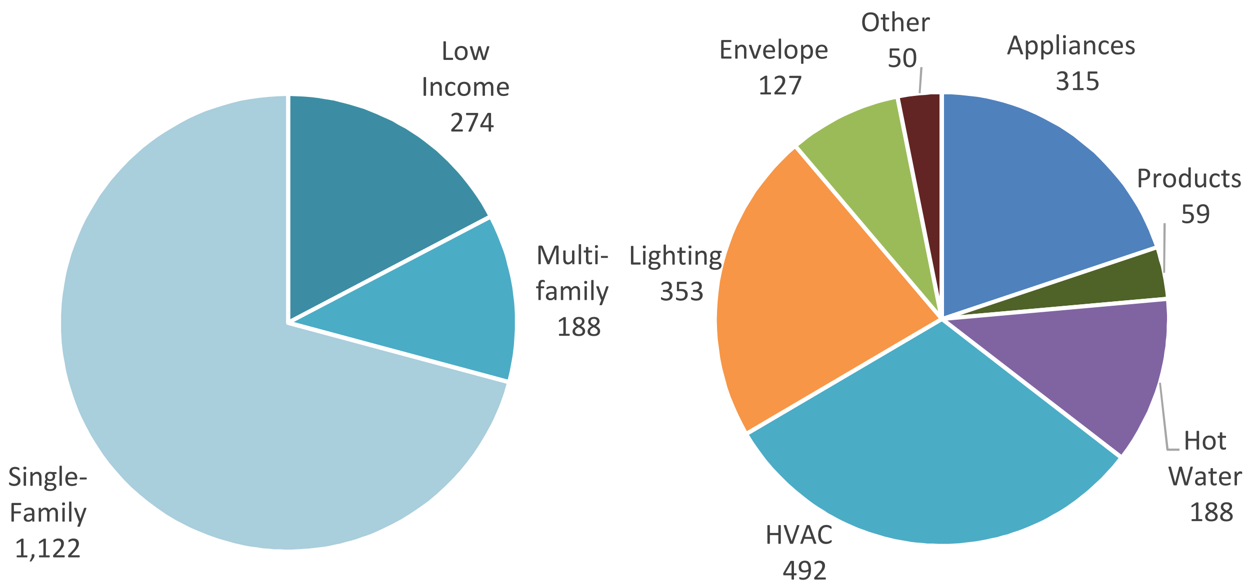


Table 35: Top Ten Electric Measure Groups - Residential Sector

Residential (Single and Multi-family)	Savings (GWh)	Low Income	Savings (GWh)
LED Interior	158	Central AC	44
Refrigerator	144	LED Interior	31
Central AC	110	Central ASHP	17
Heat Pump Water Heater	96	CFL Interior	17
CFL Interior	70	Roof Insulation	11
Home Energy Report	58	Refrigerator	11
Advanced Thermostats	50	Home Energy Report	10
LED Exterior	47	LED Exterior	9
Low Flow Showerheads	40	Low Flow Showerheads	9
Whole House Fan	39	Advanced Thermostats	9

Figure 45: 10-Year Commercial Sector Electric Savings by Market Segment and End-Use (Values in GWh)

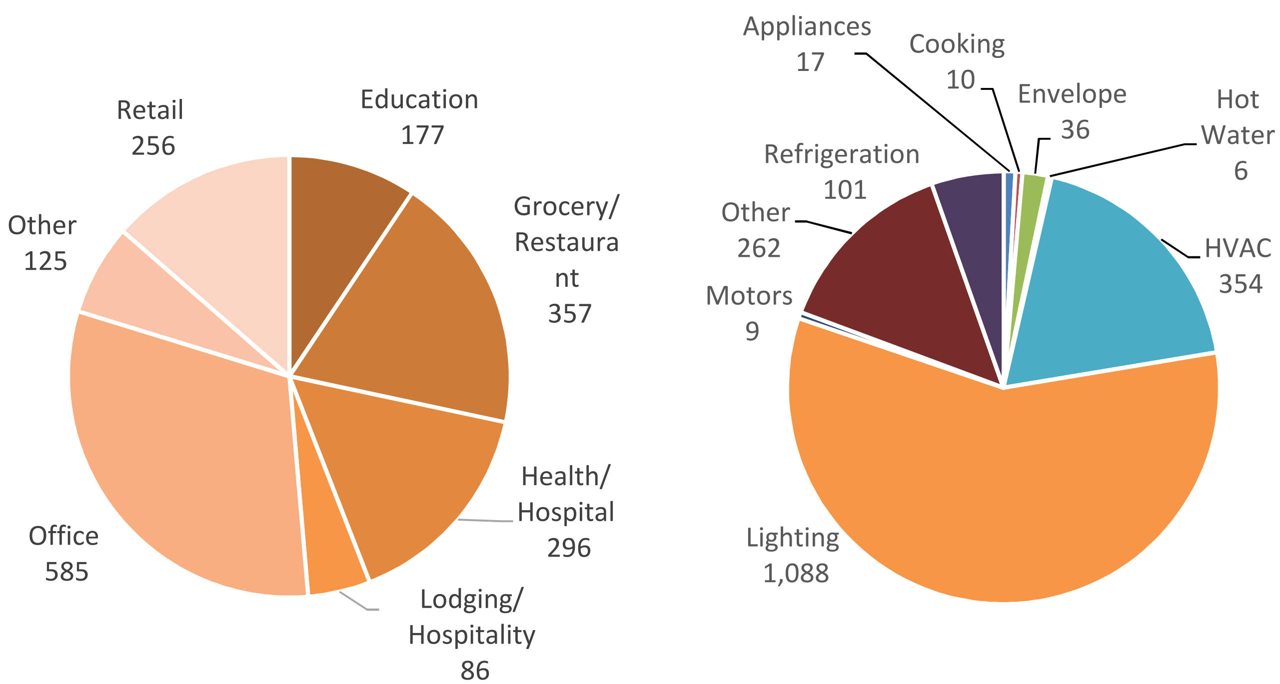
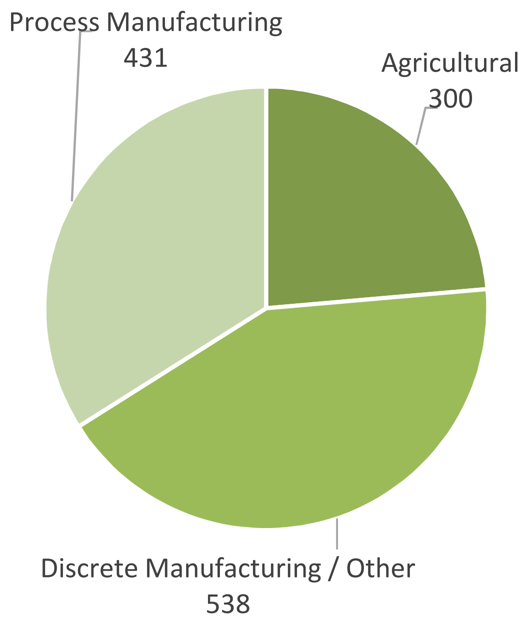


Figure 46: 10-Year Industrial Sector Electric Savings by Market Segment and End-Use (Values in GWh)



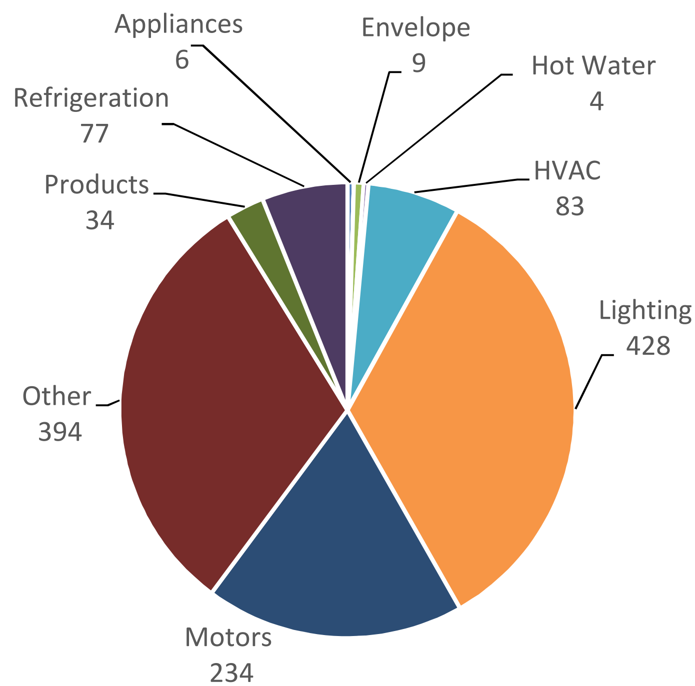


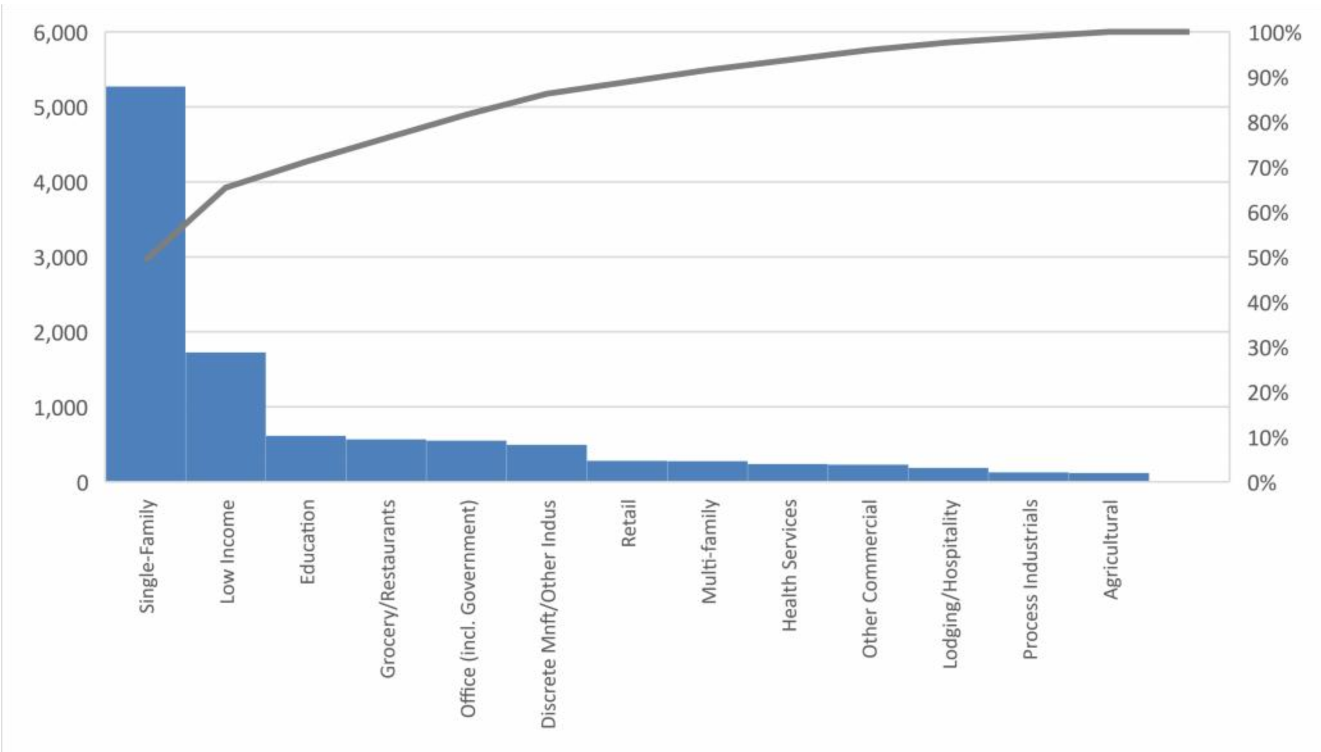
Table 36: Top Ten Electric Measure Groups – Commercial and Industrial Sectors

Commercial	Savings (GWh)	Industrial	Savings (GWh)
LED LowBay/Linear	388	VFD/VSD Pumps and Motors	234
Lighting Controls	245	LED LowBay/Linear	184
LED Exterior	212	Industrial Custom	154
VFD - HVAC	195	VFD Compressor - Comp. Air	96
EMS	95	LED HighBay	75
RCx-SEM	88	Lighting Controls	66
LED HighBay	87	LED Exterior	60
LED Interior	82	Dual Enthalpy Economizer	45
Dual Enthalpy Economizer	67	ECM Motors - refrigeration	42
Refrigerator Cover/Curtain	48	Compressed Air System	40

4.6 DETAILED GAS ACHIEVABLE RESULTS

A detailed breakdown of the statewide gas achievable potential (under the BAU+ base case) is presented in the following section. The top ten grouped measures for each sector are also presented, as well as the list for the low-income segment. Further detailed results of achievable potential by end use and segment for each utility are provided in Detailed results of achievable potential by end use and segment for each utility in Appendix K: Assessment of Potential – Results Tables.

Figure 47: 10-Year Gas Savings by Market Segment: All Sectors (values in MDth)



Overall the detailed results indicate that:

- **Single-family homes and low-income customers represent the highest gas potential:** The single-family homes and low-income customers offer significant gas savings potential stemming from furnace and envelope upgrades, advanced thermostats, and water savings. Together, these segments represent over 65% of the total statewide gas potential savings (over 70% if multi-family buildings are factored in).
- **The offices, education facilities and groceries and restaurants represent significant gas savings opportunities in the commercial sector:** Savings in these segments come primarily from commercial kitchen applications (ovens and fryers), space heating, and water heating.
- **The discrete manufacturing segment offers the majority of industrial sector gas savings:** The large number of small and medium sized facilities in this sector offer significant space heating, water heating, and custom gas measure savings opportunities.

These segments together represent over 90% of the statewide gas savings opportunity, which may justify focusing program efforts here.

Figure 48: Total Gas Savings by End-Use (values in MDth)[33]

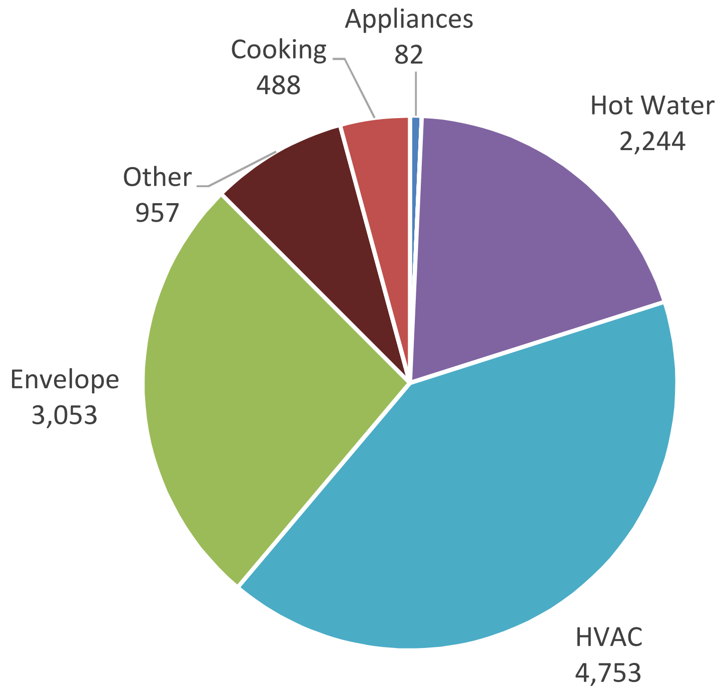
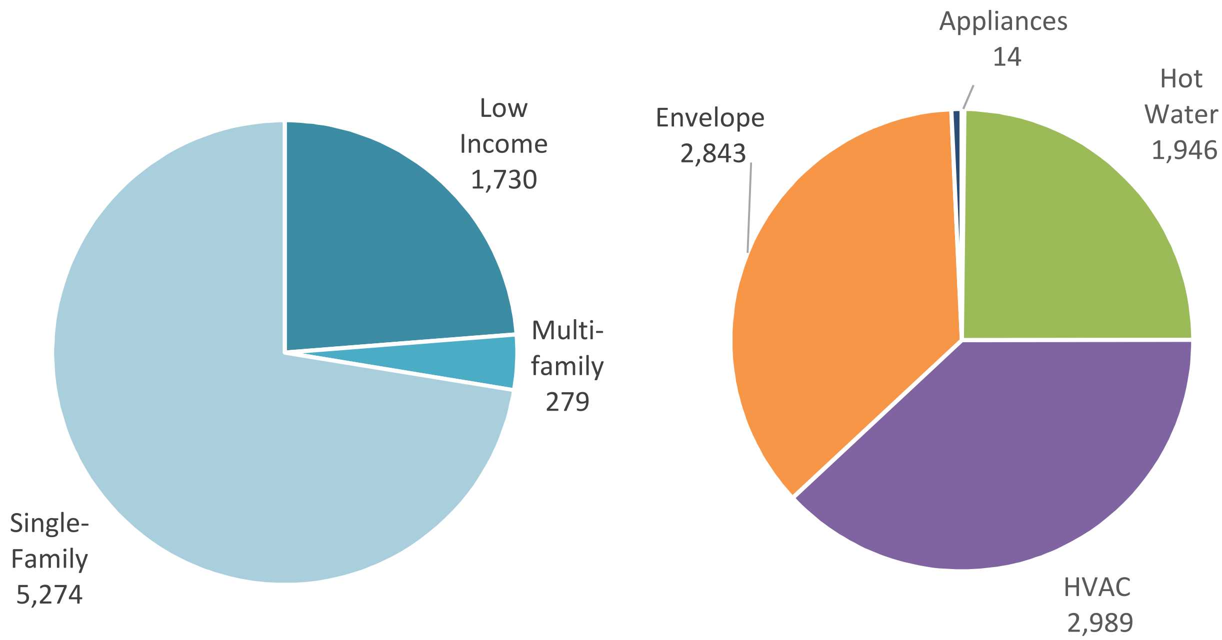


Figure 49: 10-Year Residential Gas Savings by Market Segment and End-Use (values in MDth)

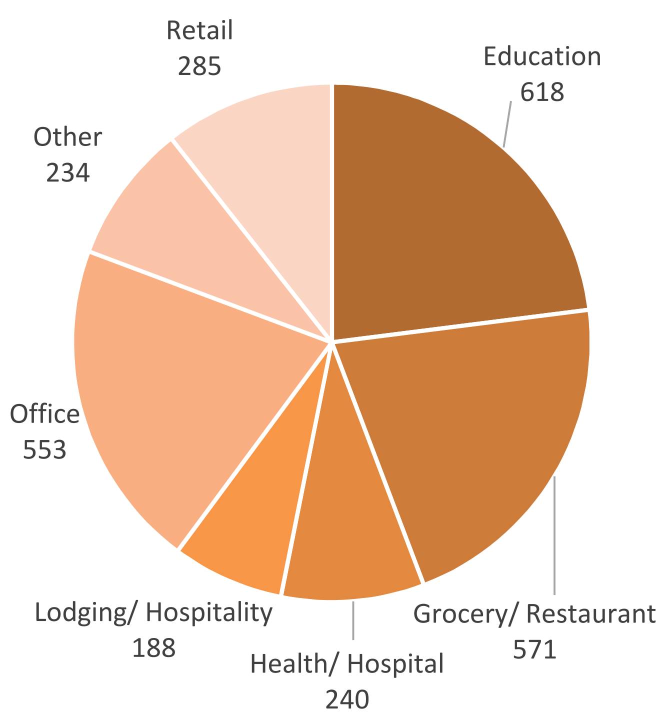


[33] Gas Savings by end-use exceeds aggregate gas savings as this report omits the negative savings from the lighting end use.

Table 37: Top Ten Gas Measure Groups - Residential Sector

Residential	Savings (MDth)	Low Income	Savings (MDth)
Drain Water Heat Recovery	1089	Furnace	413
Furnace	768	Roof Insulation	250
Advanced Thermostats	666	Drain water heat recovery	186
Basement Sidewall Insulation	567	Wall Insulation	184
Roof Insulation	507	Floor/Crawlspace Insulation	152
Air Sealing	473	Air Sealing	125
Home Energy Report	444	Basement Sidewall Insulation	124
Low Flow Showerheads	398	Advanced Thermostats	101
Wall Insulation	300	Home Energy Report	76
Programmable Thermostat	294	Programmable Thermostat	54

Figure 50: 10-Year Gas Savings by Market Segment and End Use: Commercial Sector (values in MDth)



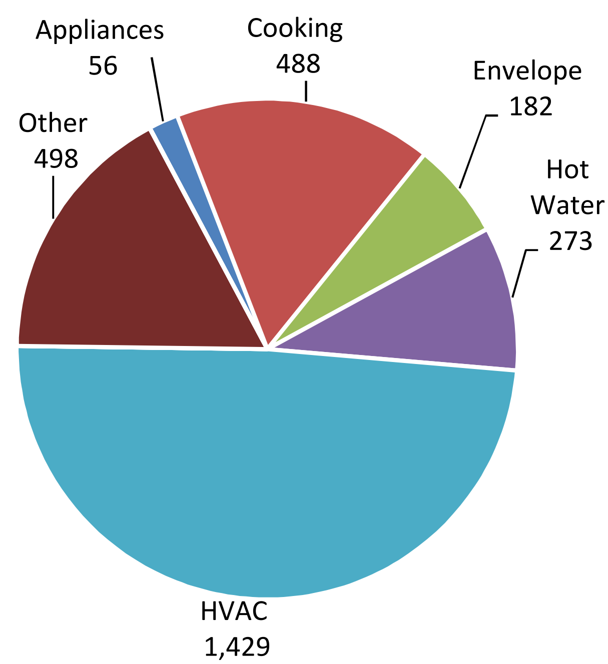


Figure 51: 10-Year Gas Savings by Market Segment and End Use: Industrial Sector (values in MDth)

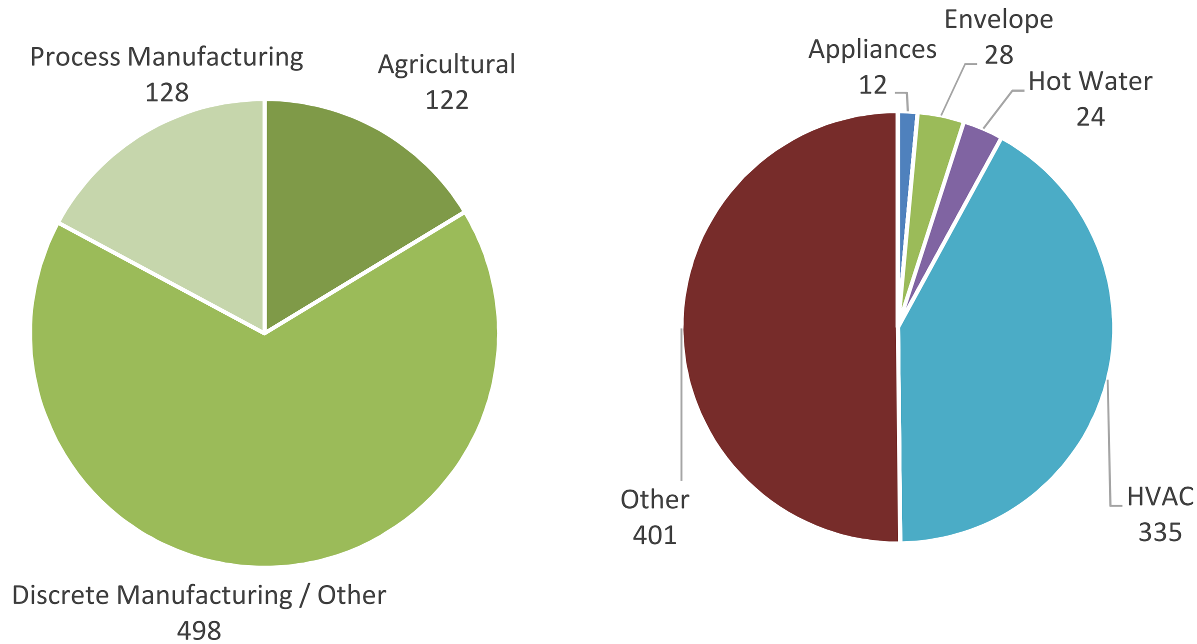


Table 38: Top Ten Gas Measure Groups – Commercial and Industrial Sectors

Commercial	Savings (MDth)	Industrial	Savings (MDth)
Ventilation Hood	493	**Industrial Custom**	270
Furnace	490	**Furnace**	175
Fryer	324	**Space Heating Boiler**	67
Space Heating Boiler	225	**Steam Trap**	55
Steam Trap	205	**Boiler Heat Recovery/Economizer**	53
Air Sealing	175	**New Construction - Custom**	40
Boiler Heat Recovery/Economizer	172	**EMS**	35
EMS	151	**Air Sealing**	28
New Construction - Custom	116	**Gas Hot Water Heater, Tankless**	20
Gas Hot Water Heater, Tankless	110	**Prog T-Stat**	16

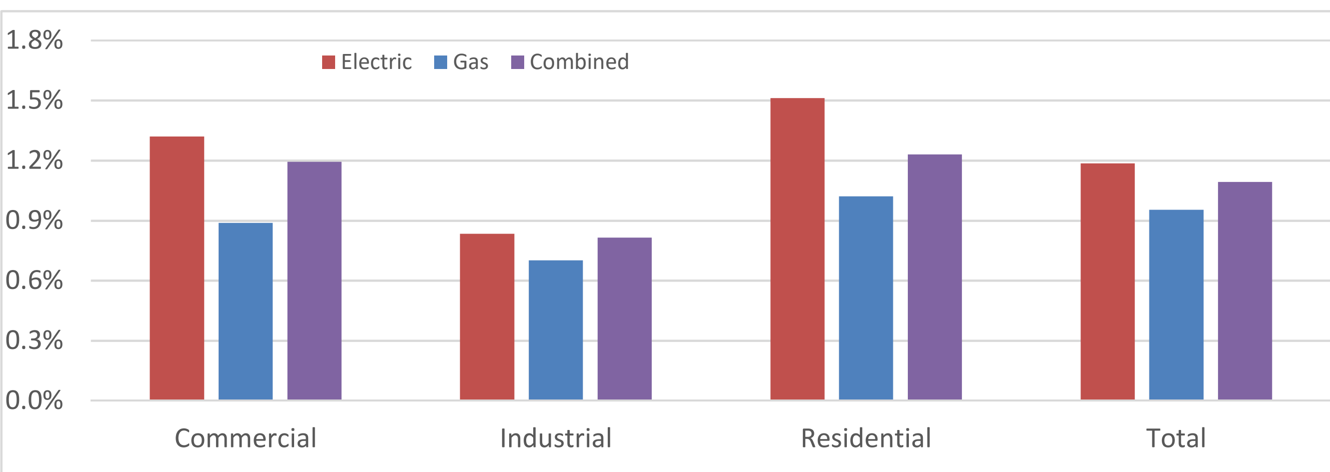
5. PROGRAM AND SCENARIO ANALYSIS

The Iowa AOP Model provides a range results including the portfolio cost benchmarks as shown in Table 39. These benchmarks are used to estimate the achievable savings of each utility's DSM portfolio and for the state as a whole. It is noted that while the BAU+ achievable program budgets are significantly higher than current utility efficiency portfolio budgets, they also come with significantly higher program savings.

Table 39: Portfolio Cost Benchmarks by Utility

	MidAmerican	Alliant	Black Hills	Statewide
Annual Electric Saving as Portion of Base Sales	1.26%	1.07%	n/a	1.19%
Annual Gas Saving as Portion of Base Sales	1.00%	0.87%	1.02%	0.95%
Annual Total Saving as Portion of Base Sales	1.14%	1.00%	1.20%	1.16%
Average Annual Program Costs (Total $M)	$ 228	$ 143	$ 26	$ 397
Annual Incentive Costs ($M)	$ 209	$ 127	$ 23	$ 358
Annual Non-Incentive Costs ($M)	$ 19	$ 16	$ 3	$ 39
$ / kWh Electric	$ 0.38	$ 0.50	$ 0.16	$ 0.42
$ / Dth Gas	$ 95	$ 93	$ 93	$ 94
$ / Dth Total	$ 104	$ 128	$ 85	$ 110
SCT Portfolio	2.0	1.5	0.9[34]	1.8

Figure 52: Annual Statewide Achievable Potential Savings as Portion of Base Sales



[34] All non-Low-Income programs for Black Hills result in an SCT of 1.0 or higher.

5.1 ACHIEVABLE PORTFOLIO ECONOMICS BENCHMARKING

Comparing the Iowa AOP Achievable Portfolio results to the current utility DSM portfolios provides valuable benchmarks of the cost per unit savings and the overall program cost-effectiveness.

ASSESSING ACHIEVABLE PORTFOLIO SAVINGS

The achievable *portfolio* savings for the modelled gas and electric DSM programs is significantly larger than the achievable *potential* results presented in the preceding sections. This is because the achievable potential captures cumulative savings, while the achievable portfolio tracks annually reported program savings. The distinction results because low EUL measures can be captured in multiple years under the portfolio savings, but only once in the potential savings. [35]

Table 40: Ratio of Achievable Portfolio Savings to Achievable Potential savings

	Electric	Gas
MidAmerican	128%	145%
Alliant	124%	151%
Black Hills	171%[36]	137%
Average (weighted by savings)	127%	145%

The following figures show present a comparison between current utility programs savings (2016 reports) and the achievable portfolio savings. These are present first using the NTGR applied in the model, and then using the a NTGR of 1, as is the practice for Iowa utility program reporting. [37]

[35] DR Measures and Home Energy Reports provide a good example of this distinction. They each have 1-year EULs, high initial participation, and slow year over year growth. As a result, they contribute to the achievable potential largely in 2018, but only the incremental growth in the program participation counts toward the achievable potential in subsequent years. In contrast, the achievable portfolio savings capture the full impact of all participants in each year of the study, as is the case with utility program reporting.

[36] While Black Hills provides incentives for gas saving measures exclusively, many of these measures carry electricity savings as well. For example, envelope improvements in a gas heated building may reduce furnace fan use, and air conditioning loads.

[37] MidAmerican and Alliant program savings from 2016 annual reports, Black Hill savings from 2015 efficiency plan

Figure 53: Electric Achievable Portfolio Comparison with Reported Utility Savings

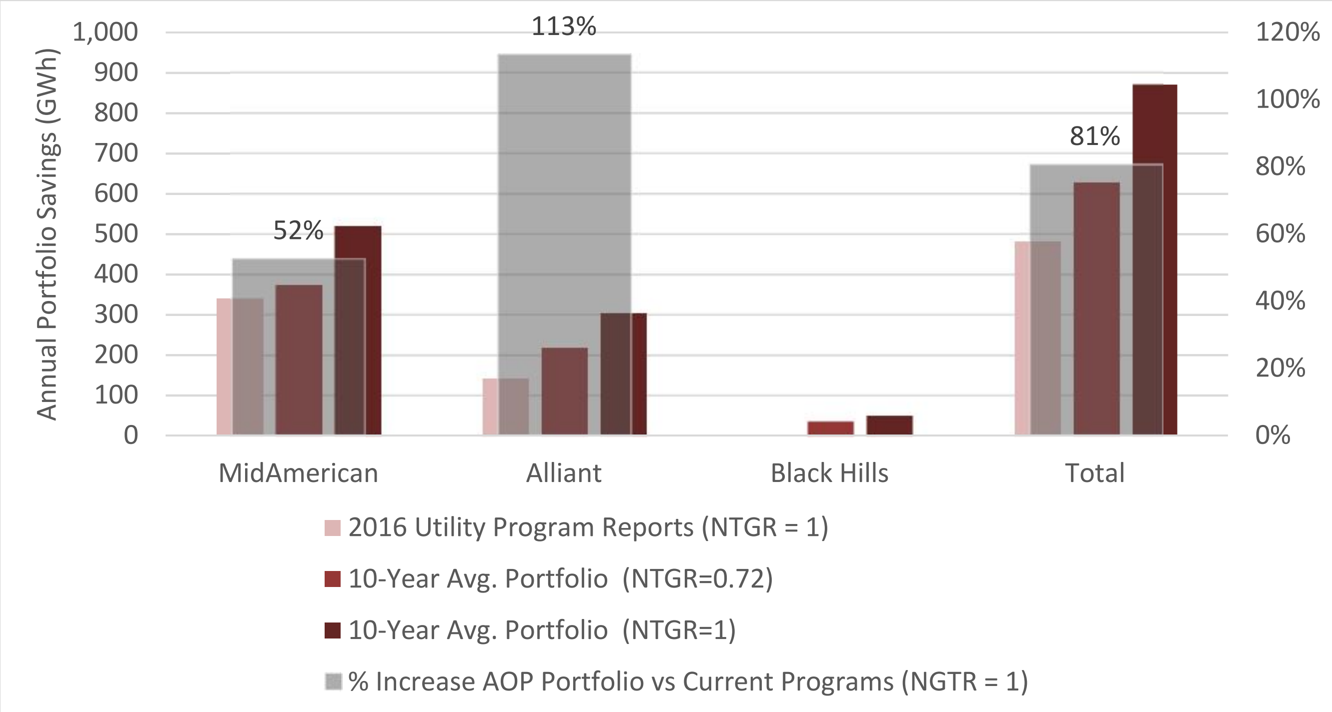
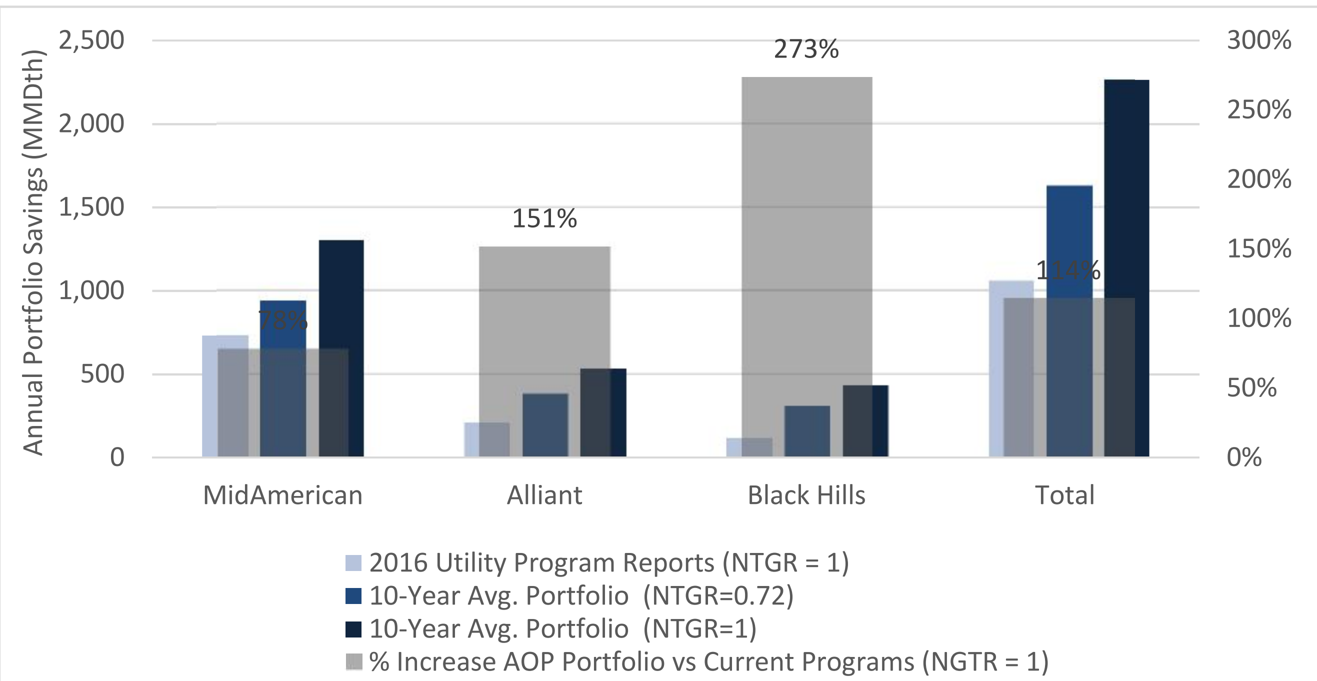


Figure 54: Gas Achievable Portfolio Comparison with Reported Utility Program Savings



From the above figures, the following observations can be drawn:

- **Achievable portfolio savings are larger than current program savings:** Even applying the NTGRs determined in the NTG Study results in gas and electric portfolio savings that are significantly larger than current reported utility program savings, which are reported using an assumed NTGR of 1.0.

- **When applying the same NTGR, the 10-year average annual achievable portfolio savings are significantly larger than current program savings:** By normalizing achievable portfolio with the current program reporting that applies a NTGR of 1 for all savings, we are able to compare the savings on an apples-to-apples basis. When applying a NTGR of 1, the statewide electric achievable portfolio is over 80% greater than the current program savings, and the statewide gas achievable portfolio is more than twice as large as current utility program savings.

Figure 55: Comparison of Annual Utility DSM Portfolio Program Costs

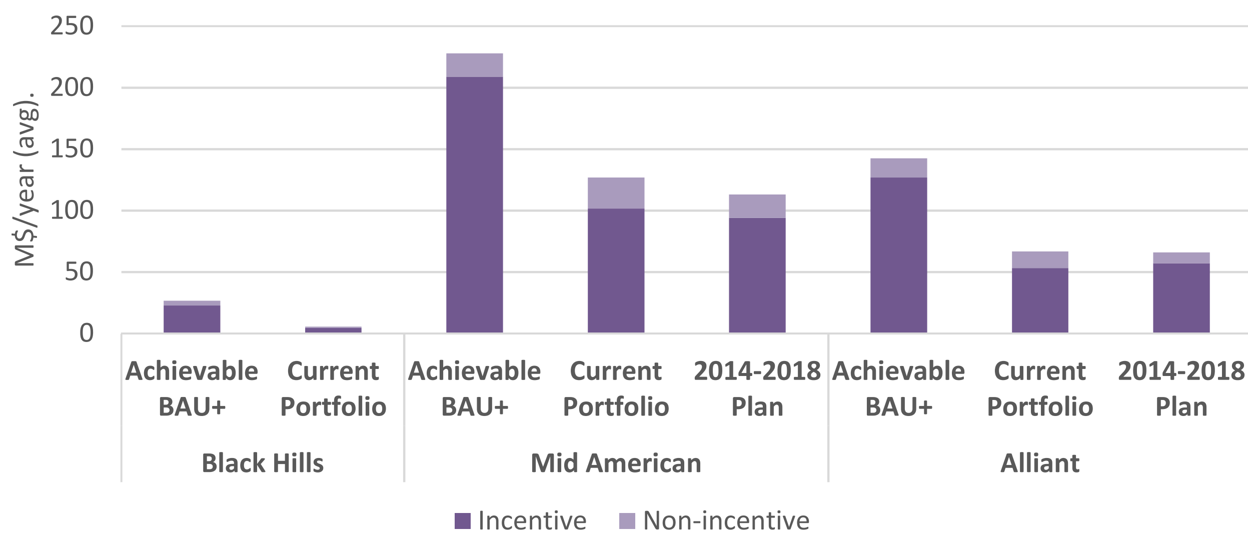
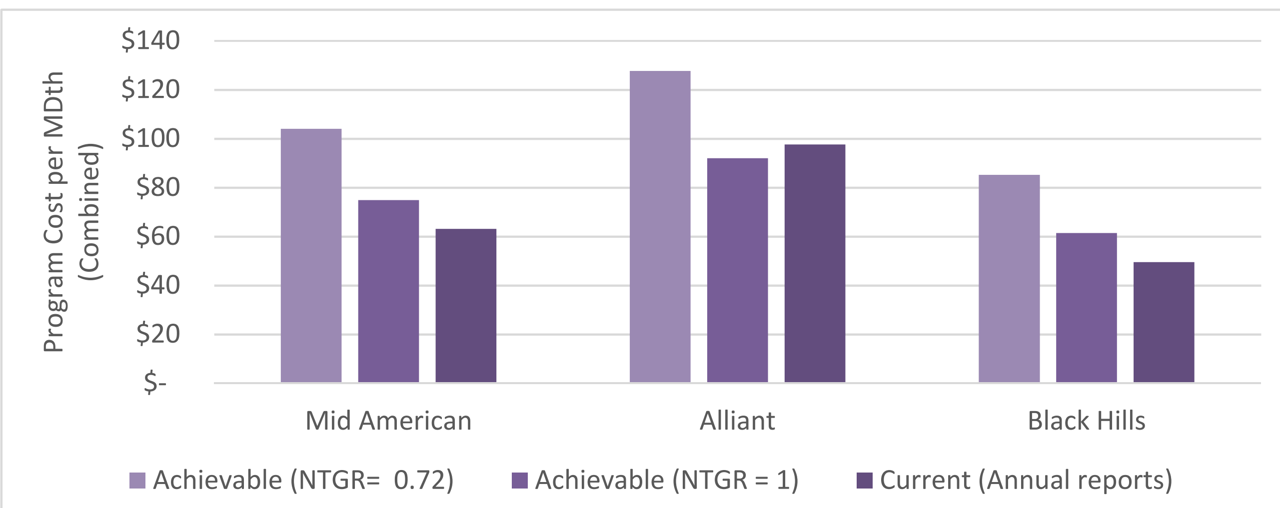


Figure 56: Comparison of Current Utility Program Costs to Achievable Portfolio Costs per Unit Savings



A few key findings emerge from these results:

- **Meeting the achievable potential would require larger utility DSM budgets:** Meeting the achievable potential results would increase current DSM program spending significantly, by as much as much as $109M per year for MidAmerican (nearly doubling current program spending) to $27M for Black Hills (a six-fold increase). Figure 55 above provides a comparison of the projected programs costs with current program costs using the 2014-2018 utility program plans and the 2016 Efficiency Program Annual Reports[38].

- **The achievable portfolios are cost-effective:** Chapter 35 Rules specify that utility portfolios and programs should be designed to be cost-effective when the Iowa SCT is applied. The BAU+ base case portfolio applies an SCT threshold of 0.5 to the measure level (except in the case of Chapter 35 special programs for tree planting, low income households, and new home code compliance where no cost-effectiveness screening was performed). The resulting mix of measures in each program and portfolio is assessed in the AOP Model's output, and the results are provided in Table 39 above. With the exception of Black Hills Low-Income programs, each program and portfolio maintains an SCT at least 1.0.

- **Non-Incentive costs may fall somewhat as a portion of program costs:** The results appear to show that non-incentive costs would decrease as a portion of program spending in the achievable potential program portfolios, relative to current programs. This is to be expected to some degree, as incentive levels applied in the BAU+ base case scenario are higher than current Iowa utility program incentive levels in most cases.[39] However, it should be noted that in order to determine participant cost effectiveness, the Iowa AOP Model counts a number of program expenses as incentives that the utilities report as administration costs, examples include direct install program kits and home energy report costs. Thus, the ratios of incentive to non-incentive costs are likely closer than Figure 55 indicates.

- **Overall portfolio level per unit savings costs are consistent with current program costs:** The Iowa AOP Model estimates the achievable potential as the cumulative _net_ savings from utility programs over the study period (2018-2027). In parallel to this study, we performed an assessment of NTGR for key Iowa utility programs, and applied those values to assess net savings in the model. The weighed-average NTGR across all programs was 0.72. By running the model with all NGTR set to 1.0, we were able to assess the program costs per _gross_ unit savings and compare them to currently reported savings costs from the utilities (where a NTGR of 1 is assumed for all programs), as shown in Figure 56 above. For Aliant and MidAmerican, the resulting cost per Dth of savings is very close to the current program cost per unit savings. However, for Alliant the gross savings costs are slightly lower than current program costs. This may be due to the model's lowered non-incentive and fixed costs as a portion of the overall costs, as discussed below.

[38] For MidAmerican and Alliant only, for Black Hills only the 2014-2018 plan values were used as no incentive vs non-incentive cost breakdown was provided in the 2015 Annual report (as provided through the Iowa AOP data requests).

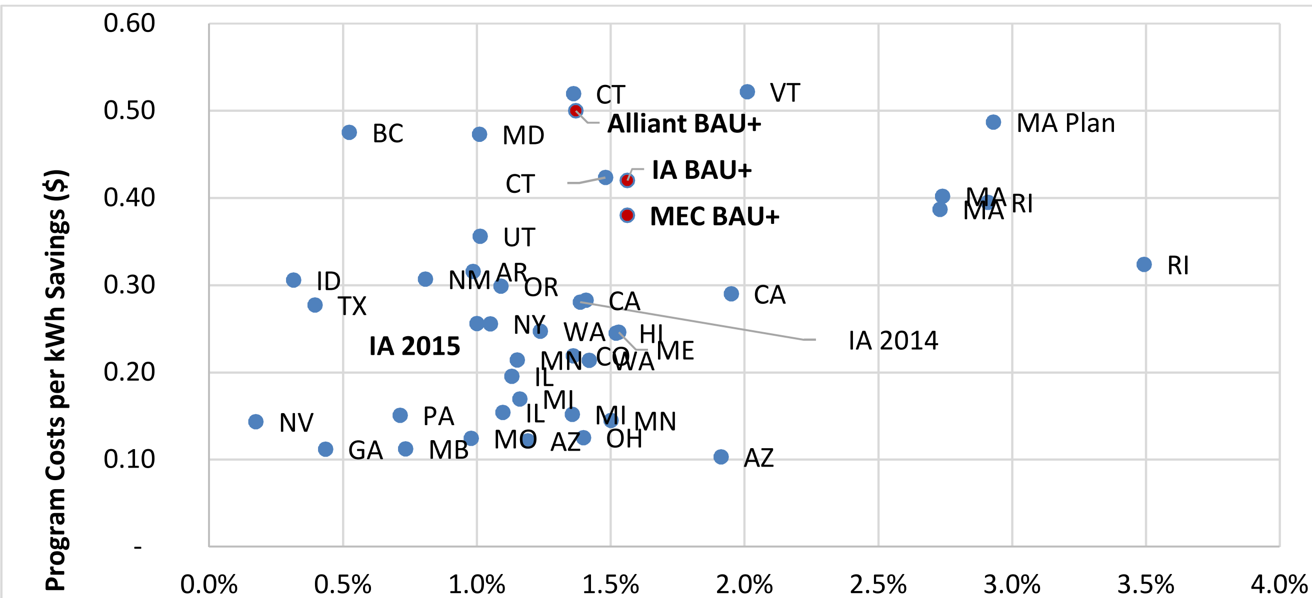
[39] MidAmerican and Alliant both have a number of programs that do not generate reported savings, but do add administrative costs to the portfolio. These were not included in the Iowa AOP Model because they cannot be linked to any specific energy saving measure, which leads to a further discrepancy between the model non-incentive costs and the current programs.

BENCHMARKING THE IOWA AOP ACHIEVABLE PORTFOLIOS TO OTHER JURISDICTIONS

Figures 57 and 58 below compare the Iowa AOP BAU+ electric and gas portfolio costs and savings to results from portfolios in other states. The charts show the plot of portfolio cost per unit savings and annual savings as a portion of sales from 2014 and 2015 program years (converted to 2018 dollars for comparison) for a range of leading jurisdictions, including historical Iowa statewide results.[40]

The Iowa AOP Model results are expressed in terms of portfolio costs and portfolio savings, which are between 255 to 125% greater than the Achievable Potential results due to the impact of low EUL measures reappearing in program savings, as explained earlier. This conversion allows for an-apples-to-apples comparison among portfolios. A few key findings emerge from the benchmarking:

Figure 57: Comparison of BAU+ Electric Portfolio Results to Reported Savings in Other Jurisdictions (2015)

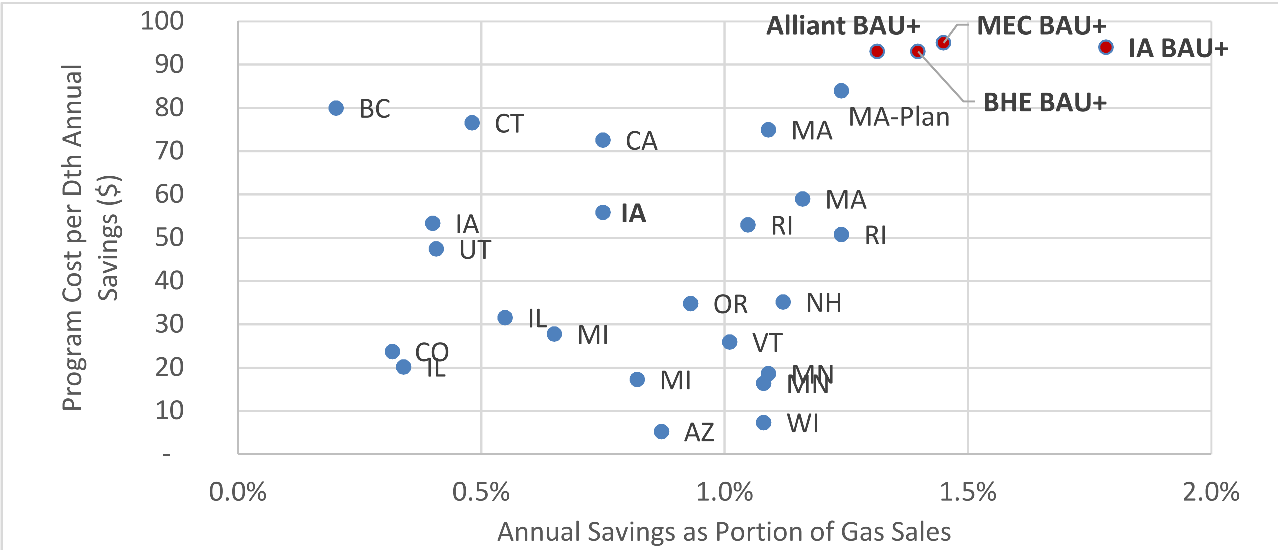


- **Iowa electric portfolio savings targets are comparable to other jurisdictions, but the costs per kWh are among the highest:** The majority of portfolios report savings of 0.5% to 1.7% of annual sales. The annual targets of all both Iowa utilities fall within upper end of the cluster of annual savings, but at a cost per kWh of savings that is among the highest of the benchmarked portfolios. The BAU+ scenario savings are somewhat higher than the reported 2015 Iowa target, but well below the aggressive targets set by state such as Rhode Island, California and Massachusetts.
- **Retail electricity prices in Iowa are lower than the national average, yet there is significant room for utility portfolio savings to increase:** Despite having lower than the national average electricity rates, Iowa's achievable potential portfolio still exceeds 1.5% in annual savings. This result is significantly higher than Iowa's 2016 utility-reported savings, albeit at a higher cost.

---

[40] 2015 Data: ACEEE, "The 2016 State Energy Efficiency Scorecard", Weston Berg, Seth Nowak, Meegan Kelly, Shruti Vaidyanathan, Mary Shoemaker, Anna Chetrum, Marianne DiMascio, and Chetana Kallakuri, September 2016.

Figure 58: Comparison of BAU+ Gas Portfolio Results to Reported Savings in Other Jurisdictions (2015)



- **Gas portfolio targets and costs are at the upper end of the range compared to reporting from other jurisdictions:** Figure 58 shows that the benchmarked gas portfolios deliver a range from 0.3% up to 1.3% of annual savings, with the leading jurisdictions exceeding 1% of annual savings. The + would place Iowa utilities squarely in the leading (over 1.0%) grouping, but at the highest cost per Dth of savings compared to the other benchmarked portfolios. Only Massachusetts approaches the Iowa BAU+ savings levels and costs, and it does so with much higher gas costs to customers. The majority of the benchmarked portfolios have significantly lower cost per Dth of savings that Iowa, which highlights the budget challenges inherent to the BAU+ scenario. It should be noted when considering these benchmarks, that the cost per unit gas savings ($/Dth) are significantly higher in Iowa than for the other leading jurisdictions.

- **Retail gas prices in Iowa are lower than the national average, yet there is significant room for utility portfolio savings to increase:** Despite having lower than the national average electricity rates, Iowa's gas achievable potential still exceeds 1.5%. The other states in the higher gas portfolio range typically have higher than the national average gas prices (e.g. MA, RI, NH). The achievable potential is significantly higher than Iowa's 2016 utility-reported savings, albeit at a higher cost.

Cross Cutting Observations

- **Iowa reported portfolio savings apply different net savings assumptions, and in reality, the difference between the past program results and the AOP Study results is wider by a factor of up to 30%:** Iowa utilities assume a NTGR of 1 for all program savings, whereas the Iowa AOP Study results apply an average NTGR of 0.72 (assessed for each measure in accordance with the NTG research conducted in parallel to this study).

- **Iowa utilities apply high discount rates and have low avoided costs compared to other leading programs:** The high discount rates applied by the Iowa utilities and relative low avoided costs further constrain the potential savings, and increase program costs in the Iowa AOP Model results, relative to other leading portfolios.

5.2 ANALYSIS OF PROGRAMS

The Iowa AOP Model provides detailed program cost and benefit analysis results for each utility, and were combined to assess the statewide program savings and costs for the 17 programs included in the model. Figure 59 shows the gas and electricity savings delivered for each of the DSM programs. Figure 60 provides the cost per unit savings for the same set of programs, excluding the demand response programs and tree planting programs because their cost structure was too dissimilar to the other DSM programs (details on these are provided later in the report). Further program details are presented in Table 41 below, including program-by-program SCT results and cost per unit demand savings.

From a review of the program results, the following observations can be made:

- **The C&I Large Business Retrofit program offers by far the most combined savings:** This program alone captures nearly a third of the statewide savings, with an SCT greater than 2. As a result, this is the best performing program in terms of cost/benefits and savings.
- **A variety of programs make significant contributions the savings in the residential market:** Low-income, home retrofit, HVAC, and new-construction programs all contribute significant savings.
- **Many of the specialty residential programs have the highest combined cost per unit savings delivered:** The residential behavioral, code compliance, and low-income programs have the highest cost per unit savings (excluding the demand response and tree planting programs discussed elsewhere). As a result, all of these programs carry SCT values less than 1.0.
- **The residential sector also offers some highly cost-effective programs, but with limited savings:** The residential tree planting and lighting programs offer the highest SCT values, but only the lighting program offers sizable savings within the study period. The tree planting program may offer longer term savings that are not captured within the study period, because the measure characterization assumed that trees typically reach maturity more than 10 years after planting.

Figure 59: 10-Year Cumulative Statewide Savings by Program

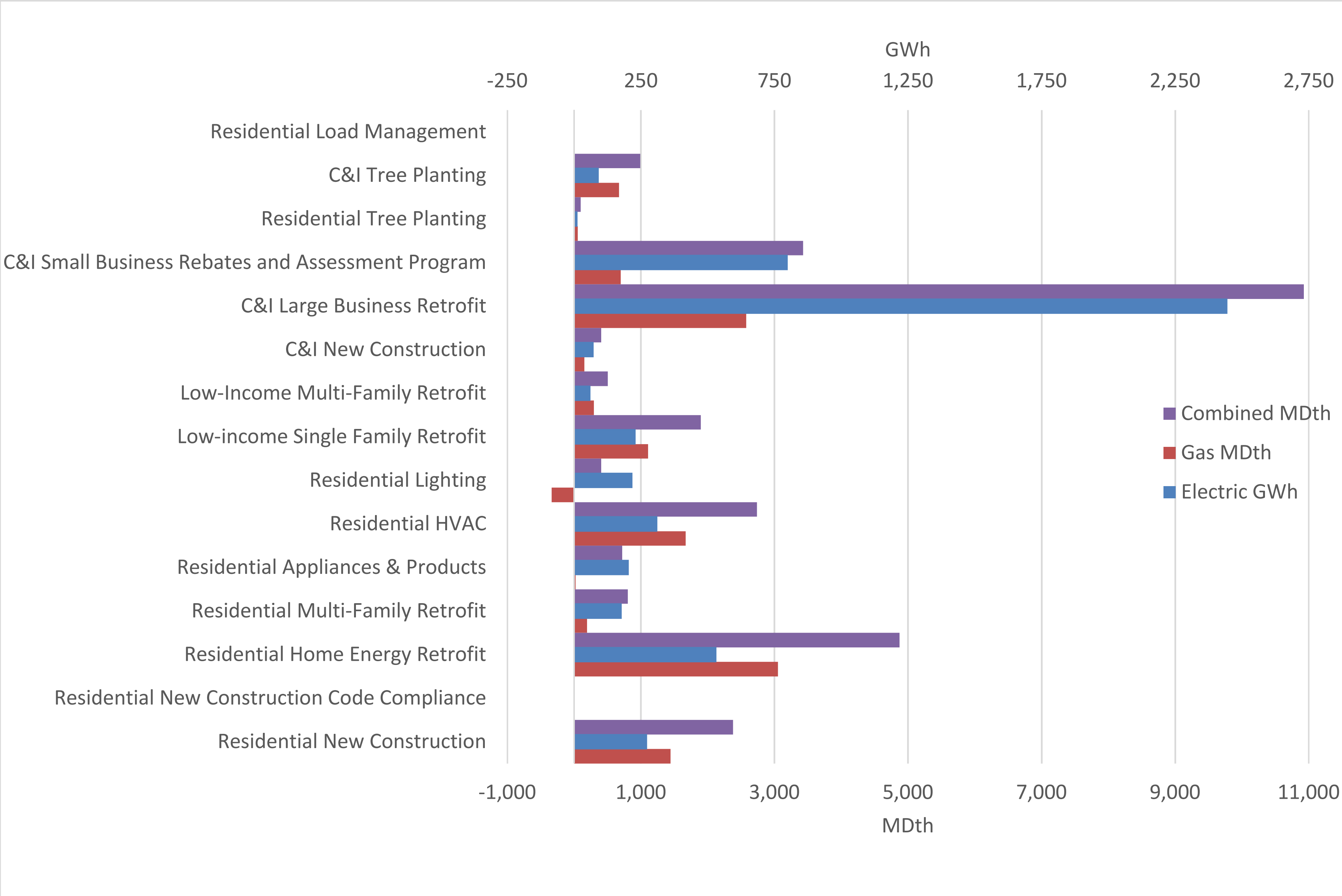


Figure 60: Statewide Program Cost per Unit Savings Comparison

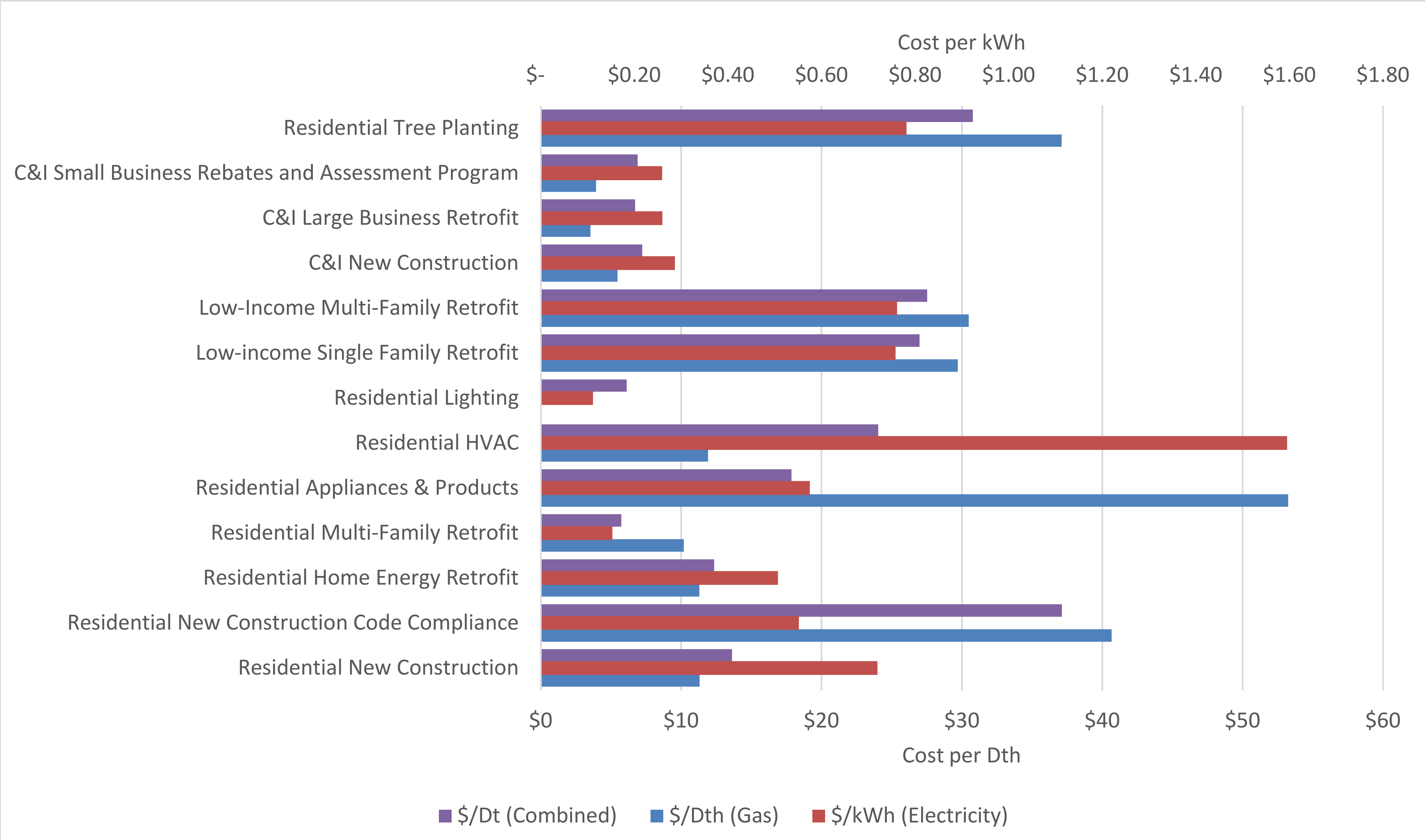


Table 41: Statewide Aggregate Program Attributes

Program	Total Savings (Dth) (Gas and Electric)	Total Program Costs $M (Gas and Electric)	$/Dth Savings	$ / MW (Electric)	$/ Dth per day (Gas)	Program SCT
Residential New Construction	2,379.4	16.5	136.3	1.72	10.2	1.61
Residential New Construction Code Compliance	8.8	0.3	371.4	0.47	24.6	0.86
Residential Home Energy Retrofit	4,874.3	53.2	123.6	2.03	10.8	1.73
Residential Multi-Family Retrofit	803.6	6.0	57.4	1.48	9.0	1.75
Residential Appliances & Products	720.3	13.6	178.7	3.55	n/a	1.24
Residential HVAC	2,737.6	54.8	240.4	2.77	10.6	1.18
Residential Lighting	408.0	3.3	61.2	1.14	0.0	6.37
Low-income Single Family Retrofit	1,897.2	62.7	269.9	2.80	23.3	0.87
Low-Income Multi-Family Retrofit	504.3	17.0	275.3	2.81	24.0	0.86
C&I New Construction	404.9	2.8	72.3	2.51	199.6	3.22
C&I Large Business Retrofit	10,929.1	78.3	67.2	2.20	7.1	2.10
C&I Small Business Rebates and Assessment Program	3,429.3	25.3	69.1	3.16	7.0	1.75
Residential Tree Planting	99.3	3.0	307.8	0.56	66.8	9.56
C&I Tree Planting	990.7	1.1	1439.4	0.30	15.2	1.97
Residential Load Management	8.6	6.0	3722.9	5.31	246.9	1.89
Residential Behavior	1.6	9.7	13.5	0.69	n/a	0.90
C&I Load Management	4.4	43.2	10769.7	0.00	0.0	2.87
TOTAL	**30201.5**	**397.1**	**109.8**	**2.61**	**122.5**	**1.75**

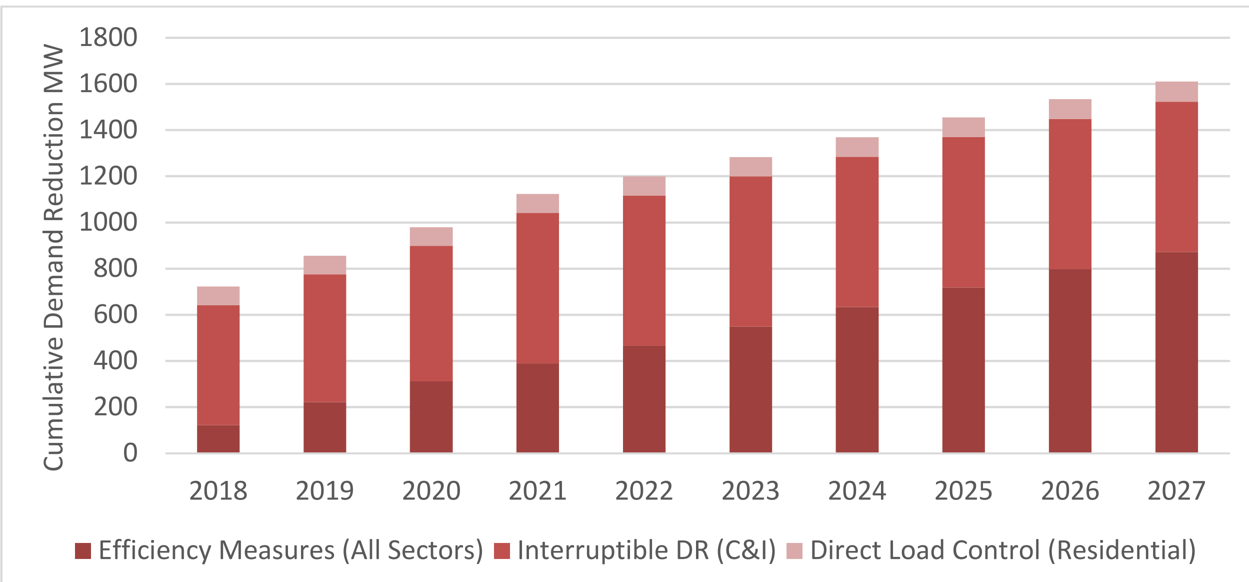
5.3 DEMAND RESPONSE PROGRAMS AND DEMAND

Two demand response programs were included in the Iowa AOP Model; an interruptible demand response program for non-residential customers and a direct load control program for residential customers. In each case, the programs were modelled to include the current number of customers enrolled in each program as the baseline program participation. The model then was set to predict expansion of these programs over the study period, within the following bounds.

- **Interruptible DR:** 50% maximum participation increase
- **Residential DLC:** up to 1% increase over current enrollment per year

The impact of each of these programs, in comparison to peak demand reduction resulting from efficiency measures, is presented in Figure 61 below.

Figure 61: Electric Demand Response Program Impacts as Portion of overall Demand Reduction



Overall a steady increase in the demand reduction is observed. The DR programs themselves show only minimal growth, while the reduced demand stemming from efficiency measures increases steadily year by year as the achievable savings are implemented. Overall the Interruptible DR program reaches a maximum curtailment of 651 MW in the model, a 13% increase over the current participation.

DR PROGRAM SCENARIO TESTING WITH IOWA AOP MODEL

A conservative approach to DR program growth was applied in the model. However, through increased incentives and investments in marketing it is possible that the utilities could attract more participation into the DR programs. The AOP Model can be used to change key assumptions and assess the impact on DR program growth. For example, the current incentive levels represent less than two-thirds on average of the avoided costs per MW of peak demand. Increasing these may increase participation and could be set to optimize to utility net returns from DR programs.

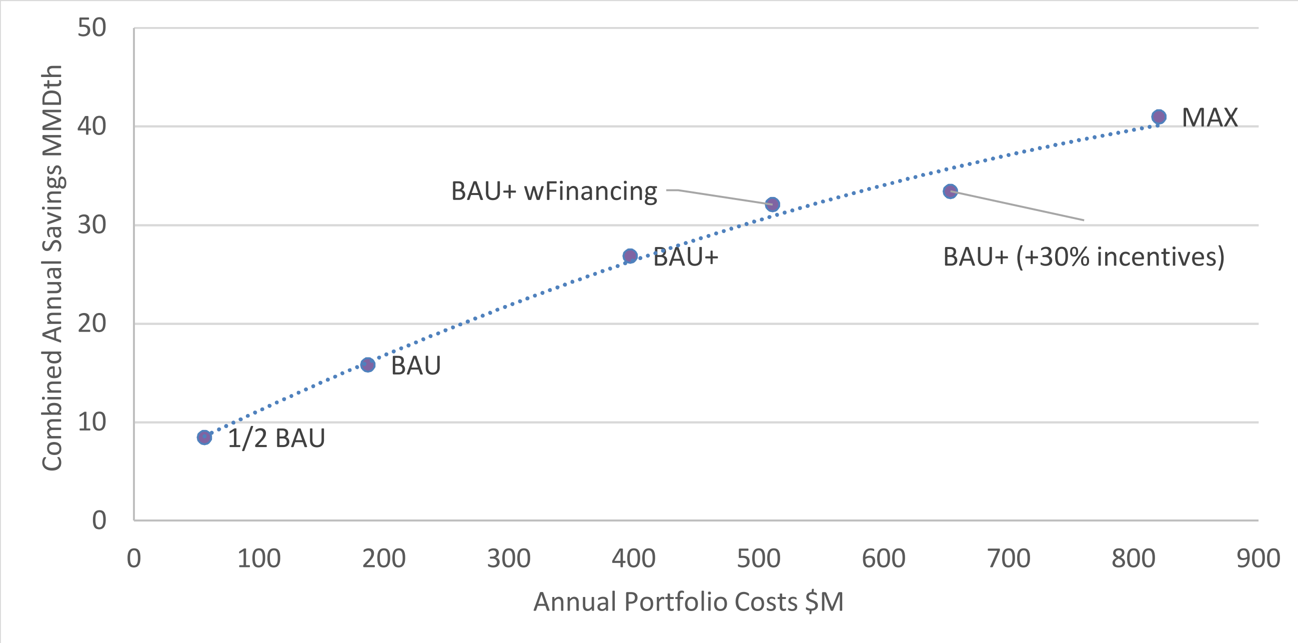
5.4 SENSITIVITY ANALYSIS

The Iowa AOP Model includes a range of fields and toggles on the dashboard that allow the user to test various scenarios through a "what if" analysis. To demonstrate the impact on the achievable potential that could result from changing economics and program constraints we ran a series of sensitivities on the following factors:

- **Incentives -** Incentives were varied in three scenarios: BAU, BAU+, and MAX (Incentives set to 100% of incremental costs)
- **Measure Costs -** Much of the economic modelling is driven by measure incremental costs, which impact the SCT and PCT results, and thereby impact measure screening and adoption. Incremental costs may change with time (sometimes very quickly, as has been seen for LED lighting). As a result, we tested the impact of varying the measure cost by a 50% increase over model values, and a 50% decrease.
- **Avoided Costs:** Because energy market prices and the generation mix changes over time, we tested the impact of a 50% increase over currently reported utility avoided costs, and a 50% reduction in avoided costs.
- **Energy Bill Rates:** Another key factor that can vary with time is the energy billing rates, which again may change with shifting economics.
- **Financing Programs:** Finally, the addition of efficiency financing programs (as per the model defined programs) was assessed to determine their impact over and above the BAU+ savings.

Figures 62 to 65 present the impacts of these sensitivities on the statewide gas and electric savings. A more exhaustive sensitivity analysis varying multiple factors simultaneously is possible using the Iowa AOP, and may be a useful exercise during program planning. However, it is beyond the scope of this study.

Figure 62: Combined Savings Under Various Incenitve Program Investment Scenarios



- **Increasing incentive levels generates higher program savings, but at a higher cost per unit savings:** Figure 62 above shows the relationship between program costs and combined savings under five incentive-level scenarios. The fitted curve highlights the impact on program budgets and savings when incentives are increased, whereby the average cost per unit savings also increases. This is a valuable visualization to demonstrate the diminishing returns from increased program budgets, which may account for discrepancies between the costs per savings under the BAU+ achievable potential scenario and current utility program spending.
- **The financing programs as defined in the model offer a notable increase in savings:** Financing impacts fall closely along the cost / savings trend line. This suggests that their cost/benefit relationship is similar to incentive programs from a utility perspective. Further sensitivities around the financing program setting could be useful to find options that increase savings at the lowest cost to the utilities.

PROGRAM OPTIMIZATION WITH THE IOWA AOP MODEL

The Iowa AOP Model offers functionality to adjust program incentive levels, barrier impacts (marketing investments), financing program features, economic inputs (discount and inflation rates), energy costs (billing rates and avoided costs) and other inputs. Changing model inputs may yield programs with savings/cost coordinates that lie above the trend line in shown in, thereby indicating a more cost-effective portfolio than the standard cases.

Program Rebalancing: By rebalancing program inputs among programs and financing options, program planning should aim find a mix of incentive levels that drive the more cost-effective programs to deliver more savings, ideally arriving at a cost/saving result lying somewhat above the shown trendline.

Figure 63: Statewide Electric Achievable Potential Sensitivity Chart

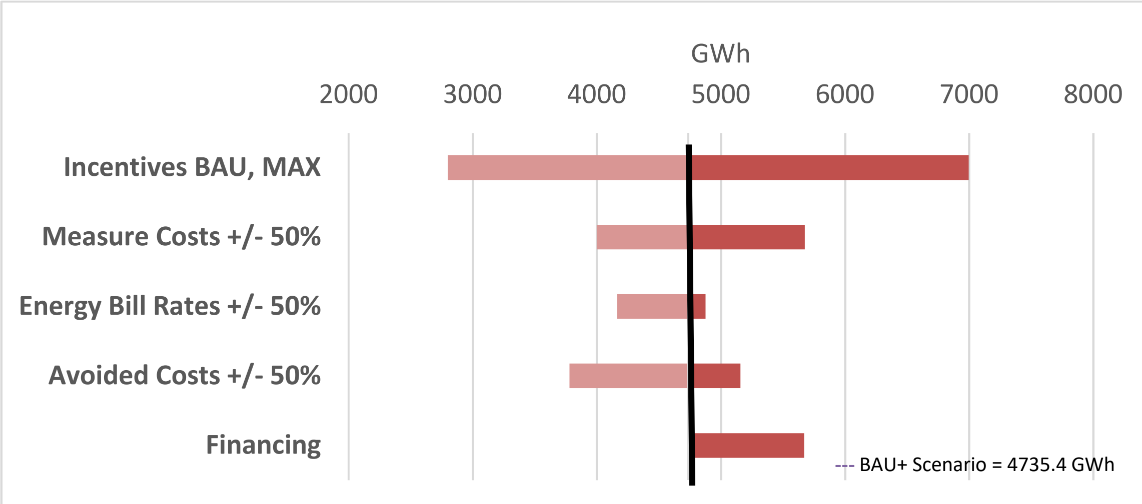


Figure 64: Statewide Gas Achievable Potential Sensitivity Chart

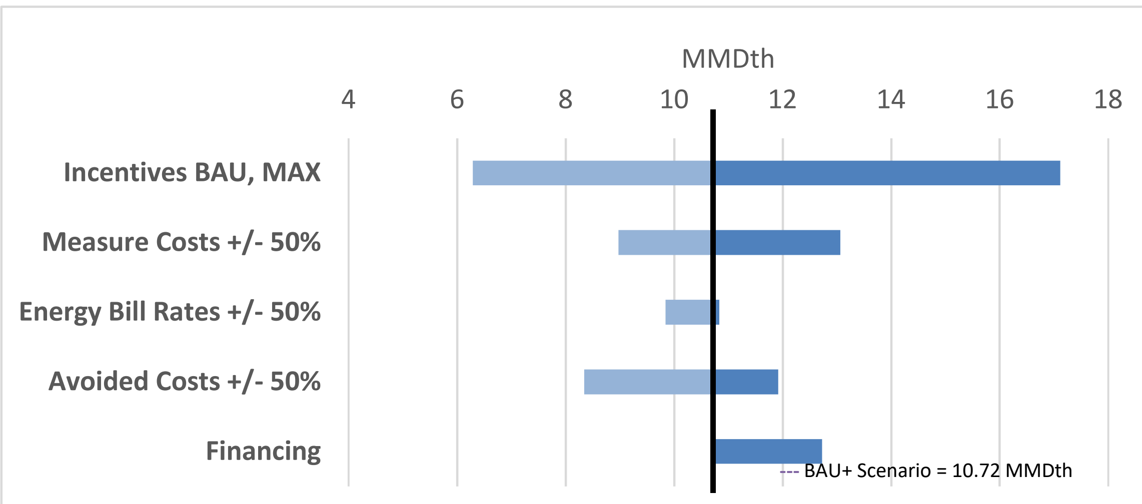
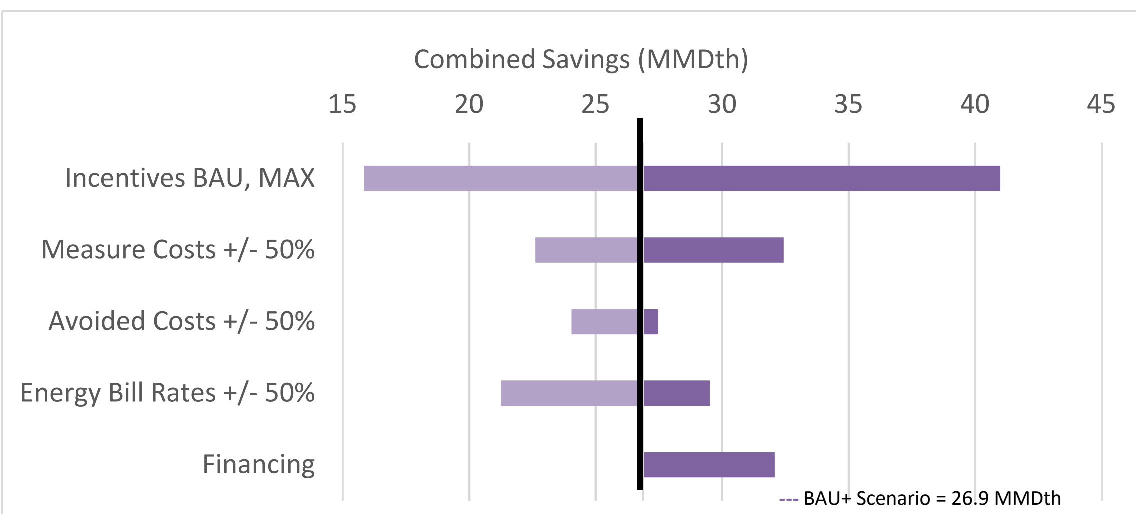


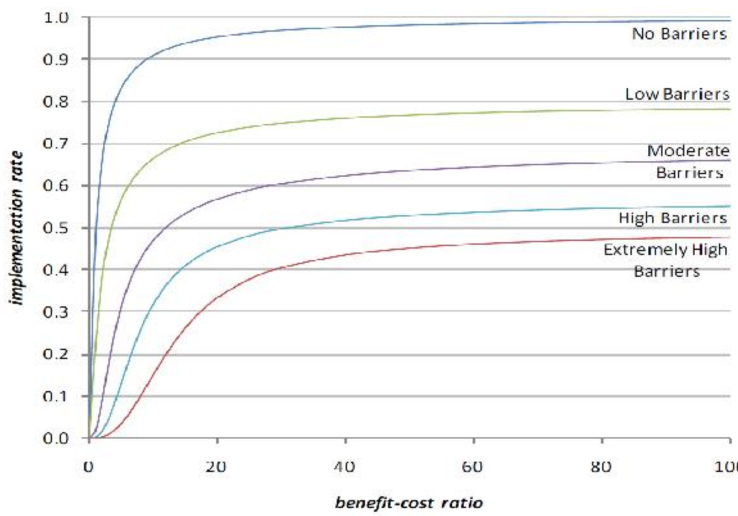
Figure 65: Statewide Combined (Electric and Gas) Achievable Potential Sensitivity Chart



Key insights derived from the sensitivity results include:

- **In all cases savings are most sensitive to changes in the incentive levels:** Variation in incentive levels led to significant changes in the program savings, likely as a result of impacting customer decision-making.
- **Gas savings are more sensitive to incentive level changes than electric savings:** This is likely due to relatively low cost of gas which leads to less favorable participant economics for many gas measures. If more gas measures face steeper adoption curves than electric measures do, then changes to customer PCT results can have significant impacts on adoption.
- **The downside potential from lower avoided costs and energy bill rates appear to exceed the upside potential from increased rates, especially for electricity rates:** This is a result of where the measures sit on the adoption curve. If electric measures sit more often on the flatter part of the curve (associated with higher PCT values) then improved economics would have less of an impact on uptake, than the potential drops associated with measures with lower PCT values and sit on a steeper part of the adoption curves.

Figure 66: Example Adoption Curves Used in AOP Model



- **Improving measure costs offer a somewhat greater upside potential, than the downside potential from increasing incremental (or underestimated) costs:** Again, this is most predominant for gas measures where participant economics are marginal and improvements can yield significant uptake growth in the steep part of the adoption curves.

5.5 IMPACT OF FINANCING PROGRAMS

By comparing the Iowa AOP Model results under the BAU+ scenario and the BAU+ with the Financing program engaged, we assessed the impact that the financing programs have on the achievable potential and program costs.

Financing Scenario Costs: When financing programs are included, the increased costs are derived from both the costs associated with the financing programs themselves (through interest rate buy-downs or the cost of capital to maintain LLRs for example) as well as the increased incentive costs associated with increased participation in DSM programs. These costs are rolled up into the 17 residential and non-residential program bundles applied in the model so that the impacts of financing can be assessed for each.

Financing Scenario Achievable Potential Increase: Similarly, the impact of offering financing programs in parallel to incentive programs is assessed for each incentive program bundle by comparing the program savings when financing is offered to the BAU+ scenario when no specialized EE financing is offered by the utilities (e.g. customers only have access to conventional financing.)

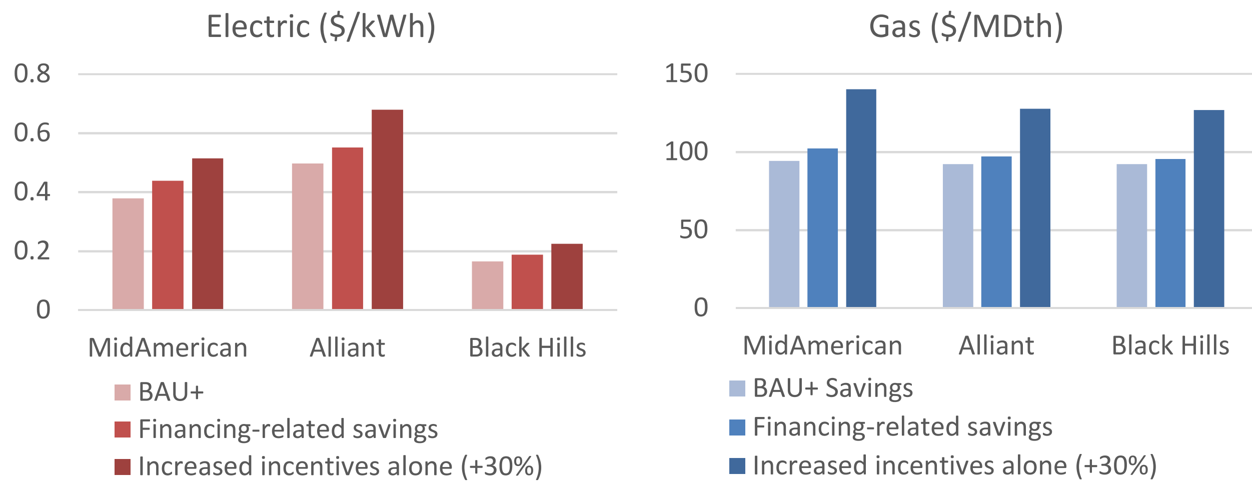
Table 42: Financing Program Costs and Impact on Achievable Potential for Each Utility

Utility	Financing Scenario Additional Cost ($M)	Electric Savings (GWh)	Gas Savings (MMDth)	Total Savings Increase
MidAmerican	70.9	613	1.1	19.9%
Alliant	37.7	311	0.5	18.2%
Black Hills	5.3	13	0.4	19.4%
Total	**113.9**	**936**	**2.0**	**19.4%**

The cost per unit savings for additional financing-related savings appears to be significantly higher than the average cost per unit savings under the BAU+ scenario. This is to be expected because the cost per unit savings of a conventional incentive program portfolio increases as the overall achievable potential increases (as shown earlier in Figure 62).

To test the relative cost-effectiveness of a pure incentive approach to a combined incentive and financing portfolio, we ran the model without financing programs, but increasing incentives until a similar level of total savings was achieved for each utility as per the financing program. Figure 67 below, shows the comparative cost per unit savings under the BAU+ scenario, as well as the cost per additional unit of savings over and above the BAU+ case obtained either through a mix of financing and incentives, compared to just incentives alone. Overall the results indicate that financing and incentives together may be more cost effective than incentives alone to access additional savings.

Figure 67: Cost per Additional Financing-Related Savings Compared to Average BAU+ Program Costs



- **Increased savings resulting from adding financing programs are significant but come at a higher marginal cost per unit savings:** Financing programs lift the overall savings levels by 19%, but the annual portfolio costs are raised by over 28% as compared to the BAU+ achievable case.
- **However, the combination of financing with incentives can be more cost effective than incentives alone:** The cost per unit savings for the additional savings supported by the financing programs is higher than for the average cost per unit saving under the BAU+ incentive scenario (as shown in Figure 62 above). However, if instead of using financing to access increased savings the programs simply increased their incentive levels to achieve the same results (the Incentive +30% case in Figure 67) the overall cost per additional unit savings would be higher. This indicates that the combination of financing and incentives can be more cost-effective than incentives alone to obtain increased savings levels.

ASSESSING FINANCING PROGRAM COSTS AND POTENTIAL USING THE IOWA AOP MODEL

The results above indicate that there may an opportunity to reduce program costs and/or increase savings targets by offering a least-cost combination of financing and incentives. The Iowa AOP Model offers functionality to adjust program incentive levels and financing program settings to assess various program design scenarios. Iowa utility program planners may wish to apply the Iowa AOP Model to assess various combinations of financing programs and incentive program designs to arrive at the lowest cost per unit savings.

The breakdown of financing's impact on savings in by end use and sector are presented in Figures 68 and 69 below.

Figure 68: End-Use and Market Segment Breakdown of Financing-Related Additional Electric Savings (GWh)

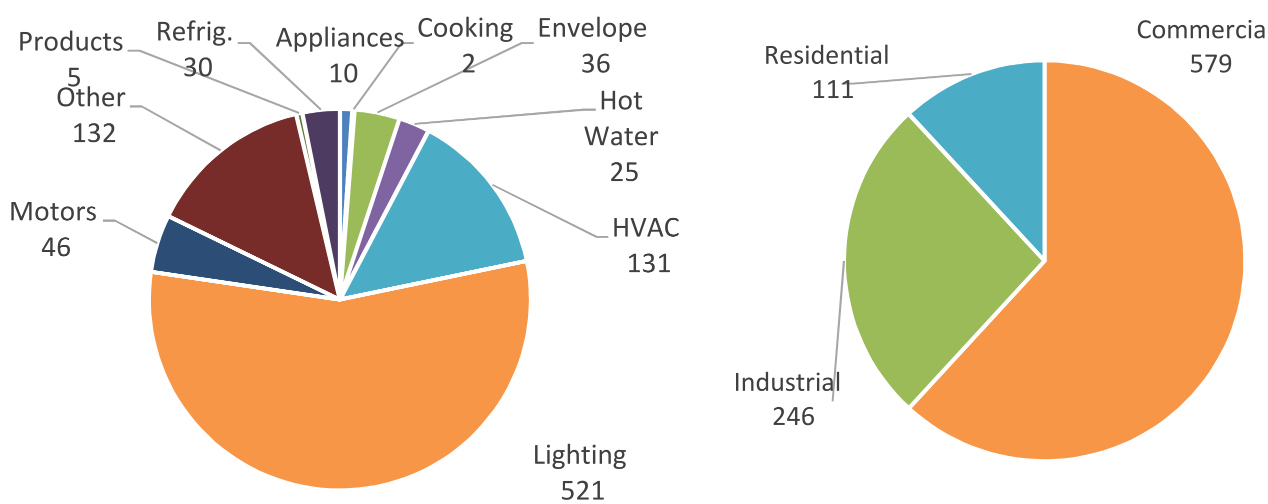
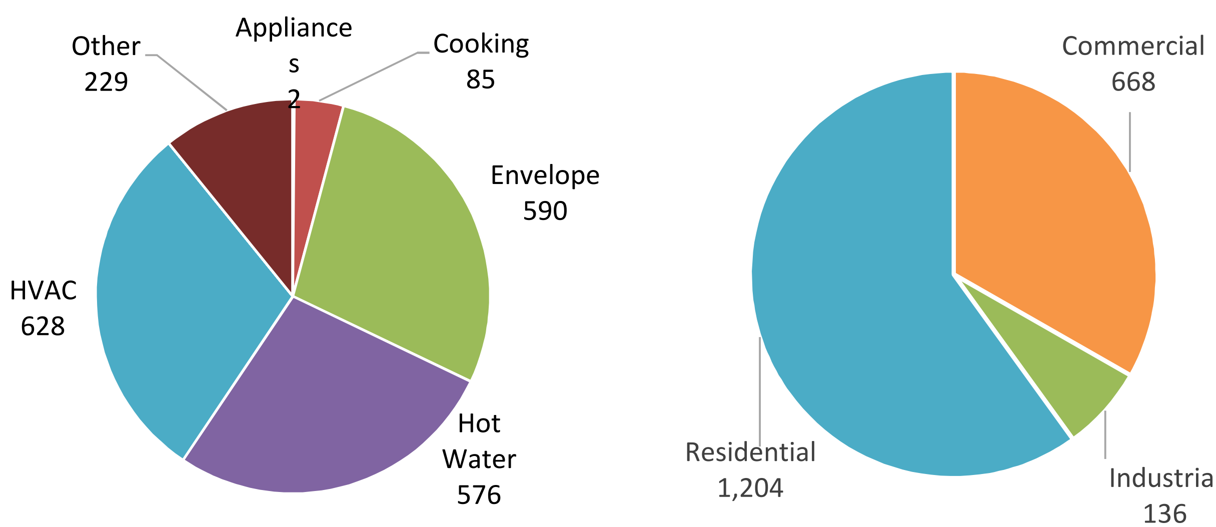


Figure 69: End-Use and Market Segment Breakdown of Financing-Related Additional Gas Savings (MDth)



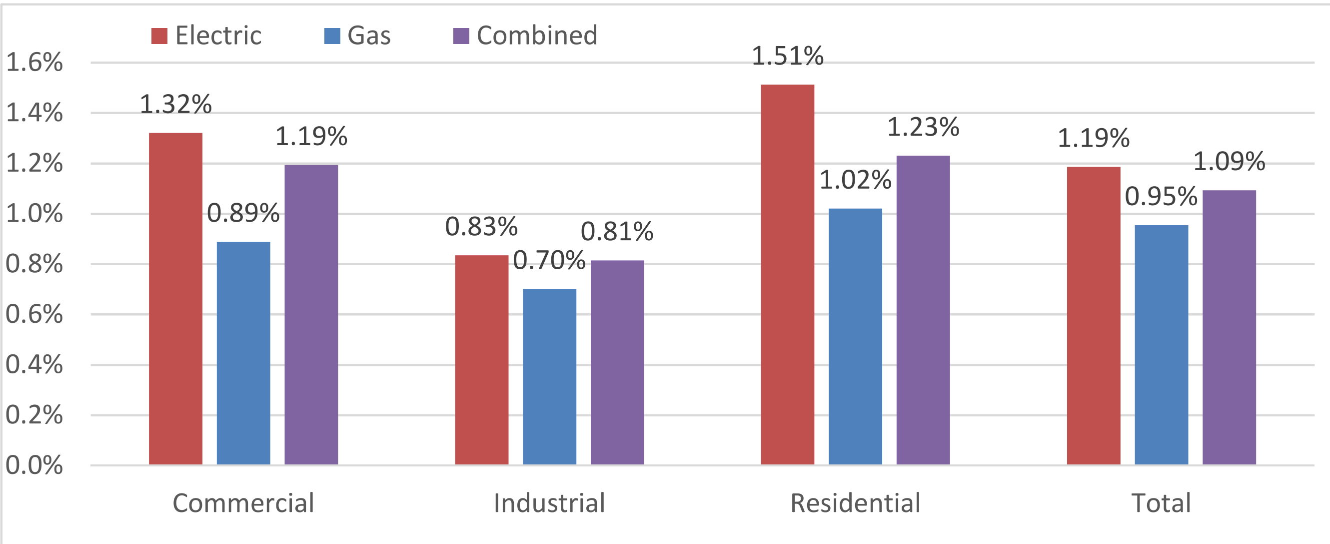
- **Financing favors measures with longer EULs:** The additional financing-related program savings is almost identical to the additional achievable potential, especially for gas measures. This implies that financing supports measures with longer EULs (i.e. most being over 10 years, and not needing to be replaced over the study period) which agrees logically with financing's fit with longer-payback measures.
- **Commercial lighting dominates additional financing-related electric savings while residential envelope, HVAC and water heating dominate the financing-related gas savings:** These results fit closely to observed program behavior for commercial OBF programs and residential home upgrade financing programs. The long EUL observation above may appear to be in conflict with the predominance of the commercial lighting electric savings, however this is comprised largely of LED fixtures which have much longer EULs than linear fluorescents.

Overall the results show that financing programs can be a useful tool in combination with incentives to support achievable savings, and in some cases, may do so at a lower cost per unit savings, than increased incentives alone can deliver.

6. STRATEGIC CONSIDERATIONS

The Iowa AOP Study provides an assessment of the technical, economic and achievable potential for the three IUA member retail gas and electricity utilities: MidAmerican, Alliant and Black Hills. Based on the results presented in this study, the following strategic considerations emerge.

Figure 70: Annual Statewide Achievable Potential Savings as Portion of Base Sales



1. RESULTS ARE COMPARABLE TO OTHER STUDIES AND CURENT PROGRAMS

The AOP Study provides comparable achievable study results to past studies and programs.

- **The achievable potential is significantly higher than current annual program savings and spending:** When the current and achievable program savings are compared with the same NTGR applied, the achievable portfolio savings are 81% higher than current electric savings, and 114% greater than current utility program gas savings. These increased savings carry a 99% increase in program costs overall. Moreover, under that same conditions, the achievable portfolio cost per unit savings (i.e. per kWh or Dth) is comparable to current program cost per unit savings (ranging from 65 less than current program average costs for Alliant to 23% higher than current costs for Black Hills).
- **The results indicate a slight increase in the achievable potential compared to the 2012 Iowa AOP Study:** The achievable potentials expressed as portion of gas and electric sales are higher in this study that in the last statewide potential study conducted in 2012. When comparing under the same NTGR assumptions, the 10-year potential expressed in cumulative savings (GWh and MDth) have increased significantly compared to the 2012 study results, albeit at a significant increase in program cost.
- **Benchmarking the achievable potential portfolio savings indicated that they are comparable to other leading jurisdiction gas and electric program results:** Realizing the study's annual achievable portfolio savings would place Iowa utilities among the leading gas and electric portfolios in the nation. However, due to lower than the national average gas and electricity prices in Iowa, Iowa utility cost per unit savings are significantly higher than the average reported in other jurisdictions for both electric and gas savings.

2. ACHIEVABLE PORTFOLIO SAVINGS ARE SUBSTANTIALLY GREATER THAN CURRENT UTILITY PROGRAM SAVINGS

The achievable potential measures cumulative savings over the 10-year period, while the AOP Study achievable portfolio savings accounts for savings from measures that may be counted in multiple program-years over the study period – e.g. such as DR measures and Home Energy Reports which each have 1-year EULs. Thus, the resulting achievable portfolio savings exceed the achievable potential savings by 33% in this study.

- **When applying the same NTGR, the 10-year average annual achievable portfolio savings are almost twice as large as current program savings:** By normalizing achievable portfolio with the current program reporting that applies a NTGR of 1 for all savings, we are able to compare the savings on an apples-to-apples basis. When applying a NTGR of 1, the statewide electric achievable portfolio is over 80% greater than the current program savings, and the statewide gas achievable portfolio is more than twice as large as current utility program savings.
- **Achievable portfolio costs are nearly double current program spending:** In both cases the cost per unit savings are nearly equivalent to current utility program costs per unit savings. Therefore, the increased achievable portfolio savings from this study's results would require significantly higher program budgets to achieve.

3. ELECTRICITY SAVINGS OPPORTUNITIES

The residential sector represents the highest savings opportunity both in terms of portion of base sales and in total achievable potential (GWh).

- **Single-family homes represent the highest opportunity:** with significant LED lighting savings potential (interior and exterior), along with AC and refrigerators and other HVAC and lighting applications.
- **The offices segment offers high electric savings:** stemming primarily from lighting (LED Low-Bay and linear fixtures), HVAC measures and other measures such as Retro-commissioning and EMS improvements.
- **The manufacturing industries collectively offer significant electric savings:** dominated by custom savings measures, as well as VFD/VSD drives, refrigeration, and lighting opportunities.

4. GAS SAVINGS OPORTUNITIES

As with the electric potential the residential market offers the greatest potential both in absolute and relative to base sales perspectives.

- **Single-family homes and low-income customers offer significant gas savings potential** stemming from furnace and envelope upgrades, advanced thermostats, and water heating savings. Together, these segments represent over 65% of the total statewide gas potential savings.
- **The offices, education facilities and groceries and restaurants represent significant gas savings opportunities:** primarily from commercial kitchen applications (ovens and fryers), space heating, and water heating.

- **The discrete manufacturing segment offers the majority of industrial sector gas savings:** The large number of small and medium sized facilities in this sector offer significant space heating, water heating, and custom gas measure savings opportunities.

5. DEMAND REDUCTION

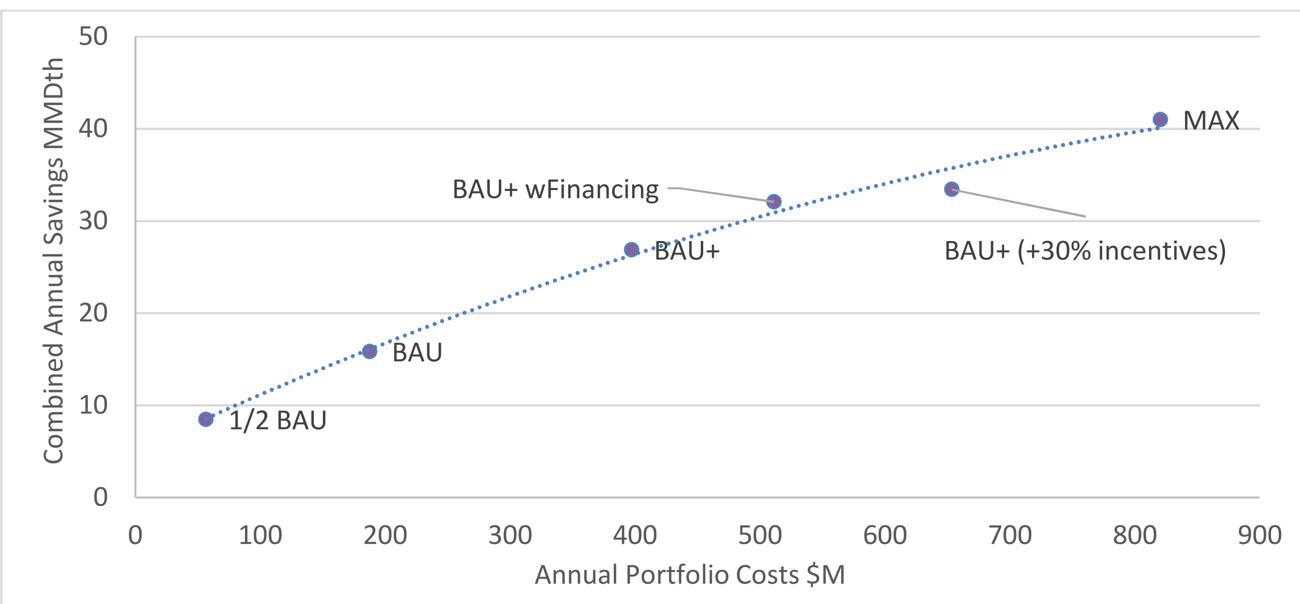
The AOP Study compared the demand reduction from the efficiency measures and

- **Gas demand reduction potential is somewhat lower than the consumption potential:** Gas peak demand savings result from the efficiency measure peak coincident use reduction. Concentrating program on measures with higher peak coincidence, such as envelope and HVAC measures could improve demand reduction results.
- **Electric demand reduction is initially driven by the DR programs, but in later years efficiency drive demand reduction begins to exceed DR program potential:** The model applied a conservative estimate to DR program growth. Testing higher incentive levels and program marketing could help the utilities to growth DR potential throughout the study period.

6. PROGRAM OPTIMIZATION WITH THE IOWA AOP MODEL - SCENARIO ANALYSIS TOOL

The Iowa AOP Model offers a scenario analysis tool that allows the utilities to test various program design configurations and assess the resulting savings, and portfolio cost-effectiveness. We tested a variety of program scenarios to identify key trends in the achievable results.

Figure 71: Combined Savings Under Various Incenitve Program Investment Scenarios



- **The marginal cost per unit savings rises as the overall program savings increase:** Figure 71 above shows the relationship between program savings and program costs under various achievable potential scenarios. As the savings increase, the programs must go after more expensive savings opportunities, thereby raising the program cost per unit savings achieved.

- **The AOP Model can be used to optimize program costs and savings:** The AOP Model allows program planners to rebalance programs and thereby focus marginal increases in portfolio savings on programs with the highest benefit/cost ratio. Finding portfolio designs that sit to the upper left of the trend line shown in Figure 71 indicates a portfolio design optimized to deliver higher savings at a lower cost per unit savings.
- **Financing can increase achievable savings significantly:** Achievable potential savings increase by up to 19% when the modeled financing programs are applied. The results indicate the financing has a larger proportional impact on longer EUL measures.
- **The combination of financing and incentive programs may deliver savings more cost-effectively than incentives alone would deliver:** Our results show that the marginal costs for additional savings under a financing + incentive approach was significantly less costly than achieving the same additional savings through incentives alone. Observing Figure 71 above, the BAU+ scenario with financing indeed sits slightly to the upper left of the portfolio savings-cost trend line, indicating that it represents an improved cost vs. savings profile compared to incentive only portfolios. Further exploration with the Iowa AOP Model could offer significant opportunities to optimize the use of financing and incentive programs in Iowa utility portfolios.

7. STUDY LIMITATIONS

While the Iowa AOP Study applied a rigorous approach to assessing the market baseline and modelling potential savings, the study limitations must be taken into account when considering the findings. It should be noted that consideration of the factors described in Table 43 could increase the gas and electric savings results.

Table 43: Study Limitations Impact of Assess Potentials

Type 1: Model Inputs/Settings	
Changing codes and standards	The EISA standards, along with many other federal standards may be at risk of not being enacted as planned under the federal administration's stated intention to lighten regulations. Removing these standards would increase the efficiency potential as baselines equipment efficiencies would not be raised through federal standards.
Residential new construction code compliance	The study relied on secondary sources to determine the impact of code compliance in residential new construction, and the assumptions applied were verified with relevant market actors.
Applied Iowa TRM Version 1 (2016)	Due to the timing of the study we applied the Iowa TRM Version 1 (2016) to characterize most of the measures in the model. Updates to the TRM in 2017 could impact program costs and savings if there are significant changes.
Future technologies	While the study included current commercially available technologies and emerging technologies, other unforeseen future technologies could become commercially viable over the study period that have unforeseen additional savings potentials.
Type 2: Sources of Additional Savings	
Non-utility programs	The Iowa AOP Study considered a full range of utility programs, but programs and policies initiated by state and local governments, and other local energy cooperatives could support further savings potential. Examples include state-lead-by-example initiatives, and home and building energy reporting and disclosure policies.
Non-utility financing	Only utility financing programs were considered. Other programs such as municipal PACE financing or lighting as a service financing could have further impacts on the achievable potential by reducing access to capital-related barriers.
Non-efficiency measures	The Iowa AOP Study did not include customer owner generation, battery storage or combined heat and power within the scope. These out of scope measures could have significant impacts on both demand and consumption potentials.

8. NEXT STEPS

The Iowa AOP Study is a key input into utility efficiency programming. Each of the utilities will be developing a 2019-2023 program plan in the coming months. The Iowa AOP Model offers unique functionality to test the program plans and portfolio design, test assumptions, and vary economic factors to compare program plan results to the assessed achievable potential

dunsky
ENERGY CONSULTING

50 Ste-Catherine St. West, suite 420, Montreal, Quebec, Canada H2X 3V4 | T. 514.504.9030 | F. 514.289.2665 | info@dunsky.com
www.dunsky.com